Applications of the Collective Action Problem for Analysis of Political Science Dilemmas

by

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Dedication

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Preface

The field of Political Science encounters a wealth of models which are used to explain various phenomena. This variety of tools is understandable when confronting the wide range of problems addressed in the subject area. Yet, as in other fields, some political scientists express a desire to simplify - to find a common ground in our attempts to explain political and international interactions. This dissertation makes a step in this direction.

This work uses a familiar and simple model - the collective action problem - to address two very different problems found in the field of political science. Variations and extensions of the collective action problem are drawn upon to model and explain the following two cases: The first problem involves addressing the causes of cooperation, and the lack of, in business transactions in the absence of contract enforcement systems. The second problem analyzes strategies and actions of opposing sides in a power struggle and demonstrates potential outcomes. Although the two topics are very different, they have common ground in that groups in each case may experience a collective action problem. Thus, tactics used to overcome dilemmas in one case may have a correspondence in another.

The issues examined and the methods used further serve to illustrate the advantages of game theoretic techniques in the study of political science topics. In both subjects, many of the results are counter-intuitive. Other results are intuitive, and the use of this methodology allows us to demonstrate how and why variables and circumstances will have the effect that they do. By appealing to game theory to find a common denominator, this dissertation is an attempt to take one step closer towards bridging the gap between the very diverse subjects in the political science field.

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Introduction: Contracts Without Enforcement

Using the "rational agent" concept, economists argue that, due to their selfish nature, humans are frequently prone to take advantage of opportunities to gain, even if the gain is at another's expense. Given these conditions, why do we observe cooperation in some places and not in others? An even more delicate concern is the balance between legal and economic activity. In particular, what mechanisms will people adopt, in the absence of a functioning legal system, in order to establish and maintain market activity? What is the impact of a working judicial system on market interactions? Can business survive without some overall system of enforcement? Will people cooperate with one another? Will trade collapse if contracts can be broken with impunity?

These important questions acquire a sense of immediacy when we explore the strategic situations in Russia and Eastern Europe. With the fall of Communism, these countries are newly creating their own governments. In some of the countries, the justice systems are in embryonic stages and are, therefore, too weak to credibly serve as a means of contract enforcement. Different countries have developed different ways of coping with this problem. The intent of this chapter is to determine what insight, if any, game-theoretic analysis could lend to this issue. I use game theory to characterise and abstract some of the methods of contract enforcement used in different countries while attempting to establish a theoretical basis for why countries differ, even when their economic and political starting points are similar.

Some insight already comes from the Folk Theorem of game theory which states that in an infinitely repeated game, within a given set of boundaries, any individually rational path is feasible.[1] Much of the research addressing the Folk Theorem attempts to find a unique equilibrium path. And yet, in the real world, we do not observe uniqueness. Instead, individuals in different places may choose very different ways to address the same problems. The issue, then, is to identify what factors may influence the choice of equilibrium paths followed. This concern becomes particularly relevant when we realise that different paths can lead to very different outcomes. Although this analysis does not and cannot claim to provide a complete explanation for the different strategies and outcomes in different places, the isolation of relevant factors may provide useful insight for understanding these differences.

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[1] The constraint regarding infinitely repeated games can be relaxed to finitely repeated games, (Benoit and Krishna, 1995). I am grateful to Steven Brams for bringing this point to my attention.

The analysis centers around two countries, Russia and Estonia, and attempts to explain differences in the paths the two have taken. Because both countries were part of the Soviet Union until 1991, there is reason to argue that the countries began at similar starting points.

In recent years, crime and broken contracts have increased in Russia, whereas in Estonia the tendency has been towards less crime and more cooperation. What factors could have influenced the differences in directions?

In Russia, there is evidence of the use of power at the individual level - i.e., violence or extortion - to enforce contracts. Because people have been able to break contracts with no danger of legal recourse, others have responded by taking the law into their own hands. People have begun either to find ways of coercing their partners into meeting contractual obligations, or they have hired others to do it for them. Unfortunately, the business of being hired to extract due payments has become profitable; it has also encouraged those who engage in this profession to seek other clients, even unwilling ones, for whom they will "offer" their services and protection. In other words, the use of power has created the incentives for many to practice extortion.

The extortion that occurs in Russia is widely described in the press.

> So routine has the payment of protection money become that it has evolved into something resembling a legitimate business

> transaction. The thugs come... representing security companies offering guard services for businesses and property. It was that kind of offer one U.S. property developer decided it could not refuse. Now the company...pays thousands of dollars each month for office guards it didn't know it needed.[2]

Individuals find it difficult to start a business without coming into some sort of contact with the mafia or other gangs. The mafia offers "a roof" to "protect" small businessmen from other groups and will additionally help them to collect bills. Moreover, they will punish anyone who attempts to turn down their "offer" of help.[3] The absence of a strong judicial system, in this case, has made power and the use of force a significant resource in the system. The sense is that people use the services of gangs either because they cannot trust their partners or because they have been coerced into the use by gangs:

> Diplomats, police officials and businesspeople all agree that one step that would help loosen the grip of organized crime is the rapid development of a legal system that can be used to resolve business disputes and enforce judgements. "State authority has dissipated, so other authority groups have stepped in," the executive director of the American Chamber of Commerce in Russia...noted dryly.
>
> "Contract enforcement has become a matter of force." In fact...it's often cheaper in Russia to take out a contract on an opponent than to try to enforce a contract against him.[4]

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[2] Witt, p. 14.
[3] Handelman, p. 69
[4] Witt, p. 14.

Estonia, in contrast, does not experience this dependence on power nor the use of extortion.[5] Although Estonians have experienced some extortion in the past, more recently ordinary businessmen have found themselves uninvolved in and untouched by these practices despite the fact that the justice system is still in the initial stages and therefore weak.[6] Given that the two countries previously were essentially governed by the same political and economic system, an interesting question is to understand why these two countries have developed distinctly different ways of dealing with a similar problem.

This problem is interesting in and of itself. Adding to its importance is that it echoes related questions posed by the field of International Relations with respect to anarchy. In the international arena, where there is at most a limited higher authority or international court to enforce contracts, deals, or peaceful interactions, how do we ensure that agreements are kept?

Within International Relations, answers to this question are divided. Realists argue that states use power, or the threat of force, as a

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[5] Extortion was used more frequently in Estonia in the early 1990s, but recently it is practically non-existent. "Q: Kas Te naite "extortion"? (See on kui mafia ütleb ärimehele ta peab maksma mingi protsenti ülle ja siis midagi ei juhtu temale ning tema kaubale). A:Eestis kutsutakse sellist asja "katuse pakkumiseks". See oli populaarne 4-5 aastat tagasi. Täna seda legaalses bisnessis praktiliselt pole." Rotov, 11 June, 1996.

[6] ibid. According to the journalist, I. Rotov, people do not even attempt to use the courts if the sum in question is less than $12,000, because the costs of the process are too expensive. Yet, he claims, people do not tend to resort to criminal activity, but use other legal forms of persuasion.

basis for enforcement. States, they claim, will be more hesitant to renege on an agreement if they believe that this action will result in confrontation (violent or otherwise) between themselves and their would-be partners. On the other hand, Neo-liberals claim that although power and the threat of force play an indisputably important role in enforcing agreements, other factors, among them repeated interactions and monitoring, can also be significant in providing a foundation for cooperation.

Borrowing insight from these two approaches, we could ask, for a system which resembles the state of anarchy, what features are we likely to see emerge? Will businesses develop their own means of cooperation with one another as suggested by Neo-liberal theory? Or will power be used as a tool for contract enforcement? What factors will influence these choices? More specifically, can we develop models which provide mechanisms to explain what features will emerge, when, and why?

The first part of this chapter uses game theory to examine which issues and what factors may influence the strategies chosen in different environments. The second part of the chapter looks into the questions raised by international relations: if there are no formal institutions for contract enforcement and cooperation cannot be maintained without them, then what mechanisms, if any, will be developed to replace the institutions?

Models: The Role of Institutions

Size of Community

Milgrom, North, and Weingast examine a similar problem. Their focus is on the problem of maintaining cooperation. They ask, "How can people promote the trust necessary for efficient exchange when individuals have short run temptations to cheat?"[7] The system they explore is one based upon similar problems to those existing in the situations described above, in that their model addresses the behavior of people attempting to engage in trade without any formal institutions to enforce contracts. From their analysis, they seek to find the extent of the role of formal institutions on contract enforcement.

To model the situation, the authors use a repeated prisoners' dilemma game. In this game, players have two options: they can play honestly or they can cheat.

The game is as follows:

	Honest	Cheat
Honest	1,1	$-\beta,\alpha$

[7] Milgrom, P., D. C. North, and B. R. Weingast, 1990, p. 1. I am grateful to Roger Myerson for bringing this paper to my attention.

Cheat	$\alpha,-\beta$	0,0

where $\alpha>1$ and $\alpha-\beta<2$.[8]

Figure 1 -- Prisoners' Dilemma

The dilemma of the situation is well known. If both players play Honest, then they receive the highest joint payoff. But each player has an incentive to cheat because, by cheating, he would receive an even higher individual payoff (since $\alpha>1$). Unfortunately, this action results in the worst payoff for the honest player. Yet in a one shot game, each player has an incentive to play Cheat, regardless of what the other player plays, because Cheat is a dominant strategy for each player - each can always do better with that strategy. For example, one player can individually gain more if she Cheats while the other cooperates. Additionally, a player will be better off playing Cheat in response to her opponent's playing Cheat. The result is that both players play Cheat, and receive 0 for a payoff, achieving the Nash Equilibrium payoff, but missing the better, Pareto superior payoff where both play Honest.

Such a model captures the sense of business interactions. Imagine that the strategies represent actions, honest or dishonest, taken in

[8] ibid, p. 6. The constraint will be addressed later. Technically, it is only necessary to have $\alpha>1$ and $\beta>0$ in order to have a prisoner's dilemma.

a trade by two businessmen. Both players can gain from trade; however, each has an incentive to cheat the other or fail to fulfil her role in the trade. In a one-shot business scenario without any contract enforcement, both players will have dominant strategies of cheating. These actions result in no trade.

When the game is repeated, however, there are more possibilities. For instance, it can be shown that if the discount factor, δ, is close enough to 1, both players playing a Tit-for Tat strategy (TFT) can be a Nash equilibrium.[9] In other words, each player plays Honest at the start of the game and then subsequently plays whatever his partner played in the preceding period.

Implicit in the TFT strategy is that the game involves two players who meet each other repeatedly. Milgrom, North, and Weingast extend the idea to a group of people. More precisely, for a society sufficiently small that people have *perfect information*[10] about one another's past actions, they develop an Adjusted Tit-for Tat strategy (ATFT). This strategy specifies that a player i plays Honest at the first stage, and then plays Cheat at stage t+1 if two conditions hold:

> "(1) i made the play at date t that was specified by his equilibrium strategy and

[9] Myerson, 1991, pp. 325-6. Also see Axelrod, 1984.
[10] This assumption will be discussed in detail later in the section.

(2) [his current partner in the game,] $M(h_t, i)$ did not make the play at date t that was specified by his equilibrium strategy."[11]

Here, M is a rule that matches traders at each stage, h_t is the history of trade through date t, and $M(h_t, i)$ represents the identity of the trader matched with player i at time $t+1$. In other words, players are matched at random. A player will play Cheat with his new partner if he knows that he himself has been Honest, and he knows that either the partner has Cheated his last opponent unfairly or that the partner has failed to punish his last opponent when punishment was necessary.

If either condition fails to hold, then i plays Honest. In simple terms, because of perfect information, I know whether the player I encounter at a current stage has played according to the rules set by his strategy. That is, I know whether he has punished a dishonest player at the last stage (thus playing Cheat) or played Honest at the last stage. Facing such a player, I would play Honest when I am matched with him at the current stage of the game; otherwise, I would cheat. The authors show that this system is an equilibrium.[12]

This model introduces support for the notion that cooperation can be maintained in a group. In other words, if the group has

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[11] ibid, p. 7.

[12] See p. 7-9 of Milgrom, North, and Weingast for the proof. The ATFT equilibrium is not a unique equilibrium.

perfect information, so that its members know who has cheated, and thus whom to punish (the authors suggest that a boycott could be an effective means of punishment[13]), then it is not necessary to have two specific traders interact frequently in order to maintain a form of cooperation as an equilibrium through a TFT mechanism.

By relaxing assumptions, we obtain more general results. Milgrom, North, and Weingast specify that $\alpha>1$ and $\alpha-\beta<2$. However, a slight modification of their proof suggests that if α and β are not fixed, but are allowed to vary within a certain range ($\alpha>1$, $\beta>0$), then the model incorporates the idea that a trade situation need not be exactly the same from period to period to achieve the same conclusion. This flexibility in the model allows the model to more closely approximate reality.[14]

It follows from the proof and analysis of the model that if the strategy of being honest when possible or punishing when necessary is profitable, then it must be that

$$\alpha - \delta\beta < 1 + \delta,$$

[13] Although a boycott is suggested, the authors do not demonstrate how the boycott would function. The analysis would require a 3x3 game, in which one of the available strategies is non cooperation.
[14] A criticism frequently voiced by Brams (*Theory of Moves*, pp. 23, 29.) and by Powell, 1991, among others, is that the repeated prisoner's dilemma is the same game in each period, an aspect of the game which does not mirror reality. Although the slight modification here can not compensate for this drawback, the repeated game is used here because although each individual interaction among traders will differ, the nature of their interactions is essentially the same.

where δ represents a discount factor ($0 \leq \delta \leq 1$). The authors derived this inequality by evaluating the payoffs that would be received if an agent desires a quick profit by cheating for one period and then returning to established behavior. Namely, it follows from comparing the gains of cheating on one step and absorbing the penalty the next, versus the payoffs due to being honest for both steps that, given certain conditions, a person is better off always playing honest. Rewriting the inequality we obtain:

$$(\alpha - 1)/(\beta+1) < \delta. \qquad (1.)$$

This equation shows for small α values (close to 1) or large β values, even relatively impatient people (small values of δ) will cooperate in the ATFT strategy. In turn, this means that if the rewards of cheating are minimal, namely, if α is close to 1 or if the costs of an opponent's cheating, β, are very large, then cooperation is more likely. We also note, however, that as δ becomes very small (close to 0), then for any realistic values of α and β, cooperation becomes endangered.[15]

In other words, if a society places a great deal of weight on the present and heavily discounts the future, then cooperation will be

[15] In other words, if we assume that β=1,000,000 or some other very large number, but α=2, then δ would have to be extremely close to 0 in order to endanger cooperation. If we consider these values unrealistic, then a very low discount factor would indeed have a negative effect upon cooperation.

difficult or impossible, even in a state of perfect information. The following examples give a more precise idea of the weight of the individual variables on the outcome.

Example:

Assume α is small (1.1), β is larger (1.5), but δ is small (.4), then the inequality is satisfied.

$$(1.1 - 1)/(1.5+1) < .4.$$

$$(.1)/2.5 < .4.$$

and cooperation remains possible.

Example:

Now assume a value of δ very close to zero, $\delta = .0001$. In this case, cooperation becomes impossible, even if the value of α is low (= 1.001) and that of β is high (=1.9). Cooperation would require the obviously false inequality

$$.000344 = (1.001-1)/(1.9+1) < \delta = .0001.$$

Milgrom, North, and Weingast use this analysis to state that because the strategy of Adjusted Tit For Tat is an equilibrium strategy, in a case of perfect information, at least theoretically, it is possible for contracts to be enforced without a formal institution and without the use of force. We may note from the examples that the possibility depends, however, on the assumption of perfect information within a community, which provides the ability of its members to interact and to be aware of each others' previous actions; on the relative gains and penalties; and on the extent to which the community discounts the future. Applying this logic to the scenarios addressed here, if, as we saw in the examples, the value for any of these variables differs between countries, then we can expect differences in terms of their possibilities for cooperation as an equilibrium outcome.

Small Groups

While the Milgrom, North, and Weingast analysis offers insight, its basic assumption of perfect information lessens its value for understanding the particular problem at hand. Instead, we need to investigate what happens when the community cannot expect a natural flow of the kind of information that the authors describe as necessary. The authors recognize this concern when they state that if players are matched in a manner in which they never interact with the same player twice, and where they have *no information* about their current partner, then we return to the Nash equilibrium where each trader will play Cheat at each opportunity to trade.[16] In other words, without a formal mechanism to enforce contracts, their model suggests that trade in a community which, for some reason, has little exchange of information will become theoretically more difficult or even impossible.

In examining this problem, information is highlighted as a crucial variable in creating possibilities for cooperation. If this is the case, then we must evaluate the role of information upon cooperation prospects and also identify factors which can decrease the amount of available information. The intuition behind the use of these variables is provided first, and then a model is created in order to rigorously demonstrate the effects of these variables.

In his examination of cooperation problems, Mancur Olson suggests that group size may be a critical factor.[17] He argues that members of smaller groups are more likely to be able to avoid the collective action problem than are larger groups. Olson's argument is based upon contributions to a public good. He claims that,

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[16] ibid, p. 9.
[17] Olson, *Logic of Collective Action*, 1965.

> in a very small group, where each member gets a substantial proportion of the total gain simply because there are few others in the group, a collective good can often be provided by the voluntary, self-interested action of the members of the group.[18]

Thus, because each individual share in the consumption of the public good is larger in a small group, members will each be better off by bearing the cost of providing the good than they would if it were not provided, and the group will be less prone to experience free-rider actions of its members.

Olson's intuition applies to public good provision, which differs from the cooperation problem described above in that, in public good provision, it is possible that unilateral cooperation can leave the cooperating player better off; whereas a player who unilaterally cooperates in a Prisoners' Dilemma will be worse off. However, the notion of greater cooperation in a small group seems logical. In small groups, members are more able to observe or communicate to one another about the actions of everyone else. Thus, these members have an incentive to cooperate in order to avoid punishment for cheating. If this logic is correct, then the information level within a small group could approximate that of perfect information. Thus, size may be introduced as one potentially important variable; however, the variable is not directly included in the above equation.

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[18] ibid, p. 34.

If size is indeed a variable that affects information, then the analysis helps explain part of the difference in extortion levels between Russia and Estonia. As previously stated, currently, in contrast to Russia, there is little incidence of extortion found in Estonia.[19] The above intuition suggests that size, can be a contributing factor towards the possibilities of cooperation.[20]

In Estonia, a small country both in terms of size and population, it is reasonable to expect a greater likelihood that people will come to know each other and learn of other people's reputations.[21] In April, 1997, there were only 69.8 thousand firms registered in Estonia.[22] Igor Rotov, a journalist who specializes in crime, used the size of the country as an explanation for why this developing country is more able, than a larger developing country, such as Russia, to control the mafia. According to him, the business community in Estonia is small enough that the people know each other. Thus, it is more difficult for the mafia to conduct their activities anonymously.[23]

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[19] Another big difference, noted by Steven Brams, is that Russia was not "dominated" by the Soviet Union. This is an important point and is further developed in the next chapter.

[20] This idea is not a new one. Olson, 1965, argues that smaller groups are more likely to avoid collective action problems than are larger ones.

[21] In fact, in spending a few days in the capital, I noticed that the same people are seen so often that even a tourist or visitor starts to recognize them.

[22] Estonian Chamber of Commerce, "Entrepreneurship," 1998.

[23] "Eesti on toesti väike riik, kus inimesed üksteist tunnevad. Eestis ei ole suurlinnu ja tsoone, kus maffia voiks elada ja areneda. Väikesel maal on maffial raske teha endale kohta
kus ta saaks eksisteerida ja areneda." Rotov, July, 1996.

In addition, other variables may affect the amount of information available. For example, ethnic components can aid the state in identifying and controlling potential problems. As an illustration, the Russian problem with the mafia is well known. Due to the existence of this phenomenon in Russia, Russians in Estonia are more carefully scrutinized, as are the Estonians who associate with them.

It is important to note that size cannot be the only relevant factor in information provision. After all, there are communities within Russia that are smaller than Tallinn, the capital of Estonia, that, nonetheless, experience corruption, broken contracts, and extortion.

> Vladivostok [in Russia's Far East] is a wreck. It's reputation for lawlessness and misery makes even hardy Russians wince. Most foreign investors look at it, shudder, and look elsewhere.[24]

Due to this disparity, the actual situation must be more complicated in that other variables must also have some effect on the amount of information conveyed and provided to various groups. These variables will be examined in the next section. The intent of the analysis here is to illustrate the potential effects that the size of a community can have in terms of information provision.

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[24] *The Economist*, October 18th, 1997, p. 54.

If we accept that size can have an effect, then we have a greater understanding of why we experience some sort of cooperation in Estonia. To connect the journalist's observation with game-theoretic analysis, it suffices to notice that if the Milgrom, North, and Weingast argument is correct, then if the business community is small enough, it can be an equilibrium to remain honest in their PD game, because it is possible to achieve honest gains in the long run. Cheating in such an environment may be unprofitable. Game-theoretic analysis supports the common sense suggestion that others will be able to learn a person's trading history at a small cost to themselves, and they will punish the cheater. Thus, the short-run gain of the cheater, coupled with threat of punishment, reduces the incentive to cheat since the long-run payoff of playing Honest is greater.

Russia does not experience the benefits of a small society.[25] In 1997, there were approximately 1 million small businesses registered in Russia, and these contributed only 10% of the Gross Domestic Product.[26] When compared to the small number of enterprises in Estonia, Russia's business community is vast. Due to its large size and resulting anonymity, it is easier to hide in Russia. It is possible to conduct transactions with people and simply refuse to pay them back afterward. The resulting harm to one's

[25] For simplicity, the analysis here is restricted to the bigger cities in Russia, such as Moscow and St. Petersburg. Problems with the issue of size are further explored in the chapter.
[26] McKay.

reputation is not strong enough, in a business community as large as Russia's, to destroy future prospects for trade. Further complicating the situation, the Russian society is frequently described as one which is focused on the present. Assuming that this characteristic is captured by a small δ value, we must expect from the model that even in the smaller cities in Russia, there will be a tendency to attempt to gain in the short-run, even at the expense of future interactions.

Information Provision

The chapter, so far, has discussed the possibility of the impact of the size of the community on cooperation in business interactions. While it is reasonable to expect the size of the community to affect the possibilities for cooperation, it would be a mistake to believe that size is the only relevant factor affecting the prospects for trade. Although verification providing complete support for this claim is not available, even the partial evidence, as seen in the example of Vladivostock, suggests that much more is involved than merely the size of the community.

This notion is further emphasized when we observe Nizhny Novgorod, a Russian city which has a reputation as a major commercial center of Russia. Although the city has a far larger business population that

that found in Vladivostok, conditions are favorable for trade, including a politically stable climate, decreasing crime rates, a governmentally created basis for economic prosperity, and an energetic application of market reforms. Reasons for Novgorod's success range from the reformist activity of the governor to a tradition of centuries of capitalist market activity.[27] However, the comparison of the state of affairs in this larger community to that in Vladivostok indicates that size cannot be the only relevant factor in determining the basis for cooperation. This is an issue, then, that should be included in an abstract game-theoretic analysis.

As a way to understand the nature of the additional relevant variables, recall that the Milgrom, North, and Weingast argument shows that the possibilities for cooperation depend to a large extent on the flow of information regarding the honesty of potential trade partners. In Western society, formal sources of this information come from professional associations, professional referral services, and the news media, whereas the more informal sources include the internet and word of mouth. While not perfect, the aid in finding partners with which one can expect mutual cooperation that may be derived from these sources is supported by the possibility of using the judicial system to enforce contracts if supposedly honest partners become dishonest.

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[27] Russian American Chamber of Commerce, "A Regional Profile of Nizhny Novgorod."

In contrast, consider a society in which the judicial system is too weak to serve as a credible system of enforcement. Here it is reasonable to expect the flow of reliable information to be crucial in providing trade. Because these societies often lack formal sources of information, a burden is placed upon networks of informal sources. This raises the important question: What is a person's motivation to truthfully inform others of honest or dishonest traders?

It is unrealistic to assume that such dispensation of information is automatic, if only because honest information can be costly to provide. On one hand, if cheated, a person may feel compensated by "getting even" with the cheater by broadcasting the information to destroy the cheater's reputation. If the benefit related to this revenge exceeds the costs, then the cheated person may be willing to undertake the action. On the other hand, people may be unwilling to assume the additional cost of informing others, especially if they have already suffered a loss through a bad business transaction, if there is a small likelihood of success, or if there is a danger of retribution.

Because honest information is costly, it is important to identify other factors which motivate people to assume the expense. As shown earlier in the chapter, one potential variable that can reduce the cost of transmitting information is small size. Another variable that captures the sense of people wanting to convey information, suggested by the case study of Estonia, is that of ethnic identity.

To explain, during the years of annexation, Estonians struggled to preserve their culture and heritage against a regime which fought to eliminate these elements.[28] Mancur Olson states that in a situation of oppression, a common ethnic bond can help people overcome collective action problems.[29] Thus, it is reasonable to speculate that ethnicity might be part of a more general factor which induces a person to bear the cost of truthful information provision. Whereas a person may not care if a stranger is cheated, he or she may want to alert a friend to the possibility. If the nationalistic bond is strong enough, then citizens may feel motivated to pass on information to others who share their nationality or ethnicity.[30]

The presence of an "ethnic bond" is only one of many potential variables that may influence willingness to convey honest information. Rather than arguing in favour of any particular factor, all variables may be summarized in a generic variable that identifies the willingness to convey honest information. My intent is to find a variable

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[28] See Taagepera, *Estonia: Return to Independence*, 1993, for more detail.
[29] Olson, 1995.
[30] Relying on shared ethnicity for exchange of information is not only used for cooperation in trade but also can be used in a brotherhood of criminals. In Estonia, for example, Russian gangs are watched. In Russia, the government has had problems with Chechen and Kazahk gangs, which have an easier time organizing because of their common ethnicity.

explaining this information provision when size is not the only factor. By doing so, I will alter the previous model to create a new one which includes both size and also other variables which may affect the level of information.

Using this model, my aim is to determine two things: first, the impact of these variables upon the level of information and, second, the impact of the level of information on the possibilities for cooperation. Olson and Milgrom, North, and Weingast suggest that variables such as size will affect possibilities for cooperation, but they do not specifically demonstrate how these variables affect cooperation. Rather, the variables are exogenous to their models. The intent of this analysis is to incorporate these variables directly into the model in order to assess their impact upon cooperation. Through this inclusiou of the variables in the model, we should be able to verify whether or not the suggestions regarding the effects of size and ethnicity are correct, and if so, how and why the variables have the effects that they do.

Information

If different factors do influence the strategies chosen, then we should expect other models to specifically incorporate these variables. Indeed, insight comes from Steven Brams's analysis of arms races, where he addresses the issue of how players cooperate or react to one another if they are uncertain about the opponent's previous moves. He claims that given a certain probability that the players can correctly detect what their opponents have done in the last stage of a game, then the strategy of Tit-For-Tat is maintainable.[31]

At this point, it is important to recall that a common theme in all of the studies mentioned here is that information is important for realizing possibilities of cooperation. Olson focuses upon means of obtaining information in order to cooperate. Milgrom, North, and Weingast demonstrate that cooperation is possible in cases of perfect information. Brams shows that information need not be perfect in order for some cooperation to develop. If this is the case, then a pertinent question becomes how much information is necessary in order for cooperation to be possible. To address this question, I create a model that

1. calculates the effect of variables such as group size and willingness to convey information upon the level of information available in a given community; and
2. determines the level of information necessary in order for cooperation to be possible in that community.

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[31] Brams, *Rational Politics*, pp. 146-156. I am grateful to his bringing this model to my attention.

From this model, we gain a better understanding of what variables should be expected to affect the possibilities for cooperation. Through this knowledge, we can also comprehend how different values for variables can produce diverse circumstances for cooperation in trade. From the latter results, we may gain an understanding of how the inhabitants of two different areas may realize two very different patterns of cooperation and/or lack of, depending on differences within the variables that affect cooperation outcomes.

While details differ, at least some of the intuition from Brams's model is applicable for the scenario described here. If players from a group face one another, they have some likelihood, λ, of knowing what strategy their opponent has played in the previous round of the game. This probability is influenced by several factors. As argued earlier, we would expect that the size of the group N (or the number of interactions n out of N people) will have an inverse effect on the probability; as the group gets larger, the probability of accurately detecting a player's previous choice, λ, decreases. It is also intuitive that some general willingness to convey honest information will have an effect upon the probability of having information about an opponent's previous strategy. If many people are willing, or even eager, to pass on honest information regarding other partners, then more information will be available. Thus, as the willingness increases in a population, then the probability of having reliable information increases.

The next step is to provide theoretical justification for this argument. To do so, we must begin to specify the model. As stated above, the model is designed to calculate the probability of obtaining relevant information, λ. When probability is used in a game-theoretic model, and the distribution function is not specified, it is reasonable to assume that the probability has a uniform distribution. However, the choice of a probability distribution function requires justification. In the case of information provision, the assumption of uniform probability is unwarranted. Consider the possibilities. Some people in a group may have information and others may not. Similarly, some people may choose to convey that information and others may not. Essentially, for the purposes of this model, the problem is: What is the probability that, in a group of size N, I will encounter a sufficient number of informed people in order to play Adjusted Tit For Tat correctly?

When the problem is formulated in this way, the model requires a different probability distribution. In discussing interactions where there is either a successful communication of information or there is a failure, the modelling assumes a distinct "success-failure" format. This means, at least on first examination, that it is reasonable to consider the binomial distribution. The binomial distribution has several advantages. Not only is the distribution function a more accurate depiction of the probability calculation, but the distribution function also allows us to evaluate the effects of other variables upon the probability of relevant information.

$$F_x(x) = P[X=x] = p_x(x) = \begin{cases} \binom{n}{x} p^x (1-p)^{n-x} & x = 0,1,\ldots,n \\ 0 \end{cases}$$

In the model, we will assume that out of a society of n individuals, b people are willing to provide truthful information about the honesty of the players. In order to make an informed decision whether or not to negotiate a contract with a new partner, businessmen will make inquiries regarding the honesty of their new business partner. Because the search for information is costly, individuals will limit their search to m inquiries.

Recalling the "success-failure" aspect of the model, we realize that some or all of the m contacts may either be uninformed or may choose not to reveal truthful information. So, a measure of reliability of the information is whether at least one of the m sources contacted is one of the k people who will give honest, detailed information about a particular candidate. This is a reasonable first measure of λ - the level of information necessary in order to play ATFT correctly. So if X is the number of the m contacted sources that will give honest information, then we are interested in computing the probability of at least one success:

$$\lambda = P(X \geq 1) = 1 - P(X=0)\,.$$

In making the inquiries, let p be the probability that any given contact will provide truthful, useful information about the honesty of the person being investigated. Now, if there are n people, where b of them will give - for whatever reason - truthful information, then $p = \frac{b}{n}$ is the probability that a particular person chosen at random will provide the requisite information. In selecting m people to question out of n, the appropriate model is sampling without replacement, because we will not contact the same source twice for a particular partner. However, reality dictates that m is a reasonably small number relative to n, it is safe to use the simpler analysis available from sampling with replacement.[32] In other words, using the

[32] Intuitively, a person may choose to contact only a small group of his or her friends in order to obtain information about a new partner. The variable m is selected randomly to account for the possibility that the group of friends does not have information about the partner - in other words, a more random selection of m should provide a greater range of information.

binomial distribution to determine the likelihood of at least one success in finding reliable information, a reasonable estimate for λ is,

$$\lambda = 1-(1-p)^m = 1-\left(1-\frac{b}{n}\right)^m.$$

Notice what happens here. For a fixed value of k and m, when n increases, the value of $\frac{b}{n}$ decreases. In turn, this means that $\left(1-\frac{b}{n}\right)$ and $\left(1-\frac{b}{n}\right)^m$ become closer to zero. Thus, the value of λ becomes closer to zero. In other words, with everything held constant except the group size, we see that as the size of the group increases, the ability to obtain the required information decreases. Thus, the model, by incorporating the variable size directly into the equation, is able to show that size does in fact play a critical role and that the effect of the variable is in the hypothesized direction.

A more precise argument for the effect of the group size upon λ is obtained by assuming n is a continuous variable and then computing the derivative:

$$\frac{d\lambda}{dn} = -m\left(1-\frac{b}{n}\right)^{m-1}\left(\frac{b}{n^2}\right) < 0.$$

The negative value for the derivative means that an increase in n, the group size, has the effect of decreasing the level of λ.

To give a sense of the impact of size upon the probability of reliable information, λ, in a community, consider the case in which m=5 and b=50. As we increase the group size, we can see the decrease in λ.

m	p	n	λ
5	.5	100	.97
5	.4	125	.93
5	.3	167	.84
5	.2	250	.68
5	.1	500	.41
5	.05	1000	.23
5	0.01	5000	0.05
5	0.005	10000	0.025

Figure 2 -- Table A

From the chart, it becomes clear that λ approaches zero as n becomes large. Thus, as stated, our intuition regarding the effect of group size upon prospects for cooperation is correct. But it is also interesting to note that even with a small likelihood of an individual having information, such as p=0.2, the level of λ, at .68, is fairly large.

The next issue to explore is what factors might cause changes in the probability. In other words, are there variables which might influence people actively to seek out others in order to pass on information? We have previously imagined that the variable b represents the number of informed people who are willing to provide honest information. It is reasonable to question what factors might influence this willingness to provide truthful information. To model the effect of these factors, we can posit that the integer b depends on other factors - b is a generic function of variables that influence willingness to convey information, b(g). Thus, a change in the variable g will change the value for b and thus the probability of a particular success, or of multiple successes.

The equation $1 - \frac{b}{n} = q$ is the probability of failure in a Bernoulli trial. Adding the effect of the variable g upon b merely allows us to accommodate the possibility that in different settings or cultures, due to ethnic, linguistic, or other factors, the probability of failure can be different. When the probability of failure changes, the probability of at least one success,

$$1-\left(1-\frac{b(g)}{n}\right)$$

also changes accordingly.

For instance to demonstrate the potential effect of a change in b due to some change in g, imagine a similar table to the one above, where n is fixed at n = 1000 and m = 5. As b varies we should detect similar changes in λ:

p	b	λ
.5	500	0.97
.4	400	0.93
.3	300	0.84
.2	200	0.68
.1	100	0.41
.05	50	0.23
0.01	10	0.05
0.005	5	0.025

Figure 3 -- Table B:

The table indicates that as b decreases, the value of λ decreases accordingly. In other words, even with a fixed population, factors - denoted by g - which increase b, willingness to convey truthful information, can have a dramatic effect upon the λ variable. As shown in the table, a doubling of the number willing to give information, raising p from .2 to .4 increases λ from .68 to .93. Thus, the amount of information available and willingness to convey that information can have a significant effect upon prospects for cooperation. In this way, it becomes possible to include factors such as size and a generic variable, which could account for ethnicity or for other factors, directly into the model. Through this inclusion, we obtain a better idea of how these factors can affect decisions.

Let

p=b(g)/n = probability that player r can detect c's strategy choice in the previous stage ($r \neq c$)

where g is a generic factor that affects willingness to convey honest information.[33]

and let

$$\lambda = 1-(1-p)^m = 1-\left(1-\frac{b(g)}{n}\right)^m \qquad (2.)$$

be the probability of knowing what the current partner has played in a previous transaction.

The New Model

[33] For simplicity, the probability, p, is assumed to be equal for all players.

We recall that the original game was as follows:

	Honest	Cheat
Honest	1,1	$-\beta,\alpha$
Cheat	$\alpha,-\beta$	0,0

where $\alpha>1$ and $\beta>0$.[34]

Looking at the game from player *r*'s perspective, we add the variable λ to indicate the reliability of information about *c's* cheating, $0 < \lambda \leq 1$. Player *r* knows what *r* has done in the past. In other words, *r* knows if he has previously played Honest or Cheat. But he does not necessarily know what his opponent has done. To model this uncertainty, we can say that, at each stage of the game, having consulted m other players, *r* knows with probability λ whether his opponent played Honest previously. If $\lambda = 1$, then we have the ATFT game described by Milgrom, North, and Weingast. If $\lambda = 0$, we have the situation of no information, which the authors demonstrated would have a NE of every player's cheating at every stage of the game.[35]

Where the current analysis extends on Milgrom, North, and Weingast's study is to determine what happens for all other λ values. The

[34] Milgrom, North, and Weingast, 1990, p. 6.
[35] ibid, p. 9.

authors address the extreme cases, but now we can handle the realm between the extremes. Namely, as λ varies, we should be able to detect the role that the reliability of information plays in providing the possibilities for cooperation.[36] An analysis of the game proves that if

$$\lambda \geq [\delta\alpha + \beta + \delta\beta]/[1 + \delta + \beta + 2\delta\beta + \delta\alpha - \alpha] \qquad (3.)$$

or

$$\delta \geq \frac{\lambda(\alpha - 1 - \beta) + \beta}{\lambda(1 + 2\beta + \alpha) - (\alpha + \beta)} \qquad (4.)$$

then cooperation can be maintained.[37]

The first inequality designates a lower bound on the probability of reliable information, below which cooperation cannot be maintained as equilibrium behavior. The interesting aspect of this equation is that the bound is determined by aspects of the game - the business dealings - given by α and β, and by a measure of patience, given by δ. These factors combine to provide a lower bound on societal factors - group

[36] This revised game differs from the original in that at each stage of the game the players randomly interact and exchange information before being matched with a player to play PD.
[37] See appendix A for computations.

size, propensity to share information - which allows for the possibility of cooperation and a level of self policing of the game.

The second inequality is useful for comparison with the inequality in (1.). In fact, note that if there is perfect information, $\lambda=1$, then, as expected, we re-obtain Milgrom, North, and Weingast's result, and Equation 4 becomes identical to Equation 1. In turn, Equation 4 provides a useful measure of the possibilities for cooperation in terms of available information.

Because λ is determined by several variables, a sharp difference in any of the variables between two different communities could mean the difference between cooperation and cheating, even if all other variables are equal. In other words, if any specific variable differs between two societies, then those societies would be more likely to follow different paths. For instance, if the group size were very different between two societies, as it is in the business communities of Russia versus Estonia, then we would expect that the larger society would experience larger problems in achieving cooperation. Other differences that could cause variations in the cooperative outcomes between two societies would include differences in the discount factor, the penalty, or the gain from cheating, on in any of the variables affecting λ, such as desire to give information. If many variables differ, then the paths chosen by the two societies are likely to be even more separate from one another. This distinction provides a great deal of insight about why different communities may follow different equilibrium paths.

To better demonstrate the potential effects of the variables on information flow and cooperation, some examples are included.

1. Imagine two societies Y and Z in which all factors are identical except that one has a much larger population than the other. We recall that

$$\lambda = 1 - \left(1 - \frac{b}{n}\right)^m$$

and we know that if

$$\lambda \geq [\delta\alpha + \beta + \delta\beta]/[1 + \delta + \beta + 2\delta\beta + \delta\alpha - \alpha]$$

then cooperation can be maintained. Society Y has a population 10 times larger than that of society Z, $n^Y = 10n^Z$. We know that the larger n is, the smaller p becomes, so the λ for society Y should be smaller than for Z. In table A, a difference in n by a factor of 10 shows a radical impact upon λ. For example, if society Z has a population of 100 and Y's population is 1,000, then Z will have a λ = .97 and Y's λ will be only .23, significantly lower. Similarly, if Z's population is 500 while Y's is 5,000, then for Z,

λ=.41 which entails a low but possible chance of cooperation, but for Y, λ=0.05, a very unlikely possibility of cooperation.

2. A change in other variables could have similar effects. If, due to differences in wealth or in natural resources, α, the amount to be gained from cheating, were significantly larger in society Y than in Z, then similar circumstances could arise. Now the right hand side of equation 3 for Y is larger than that for society Z.

$$[\delta\alpha^{Y} + \beta + \delta\beta]/[1 + \delta + \beta + 2\delta\beta + \delta\alpha^{Y} - \alpha^{Y}] >$$
$$[\delta\alpha^{Z} + \beta + \delta\beta]/[1 + \delta + \beta + 2\delta\beta + \delta\alpha^{Z} - \alpha^{Z}]$$

If the difference in the levels of the variable α in society Y and in society Z are such that, in Y, the inequality is not satisfied, and λ is not sufficiently large to maintain cooperation, while this is not the case in society Z, then we have another explanation for why cooperation may take place in society Z and not in Y.

3. For a third example, consider the effect of the variable δ, the discount factor. We saw earlier that relative levels of patience can have an effect on the potential for cooperation. Specifically, if a group strongly discounts the

future, then possibilities for cooperation will diminish and eventually disappear. If society Y is strongly oriented in present consumption, whereas Z values the future, then we would expect that Z would experience more cooperation than would Y. If we compare the two extremes, $\delta=0$ and $\delta=1$, we see that the right hand side of equation 3, or

$$[\delta\alpha + \beta + \delta\beta]/[1 + \delta + \beta + 2\delta\beta + \delta\alpha - \alpha]$$

is larger if $\delta=0$ than if $\delta=1$. This fact means that it is more likely that the necessary inequality will not be met, and cooperation will not be possible. Borrowing from this intuition, if the differences between the values for δ are such that the inequality is not satisfied for society Y but is satisfied for Z, then Z is more likely to experience cooperation than is Y.

This idea holds interesting consequences for Olson's collective action problem. Olson argues that small groups are less likely to face the free rider problem than are large groups. This model postulates that size does, in fact, have an influence. But the model goes beyond Olson's explanation also to show that size need not be the only influencing factor. The model demonstrates the effects of variables aggregated in the variable g, such as culture, education, ethnicity, and religious convictions, to name a few, upon contributions to the group.

Comparative Statics

Because we recognise that differences in the variables can affect prospects for cooperation, we should be able to make comparative statics statements, which yield more precise descriptions of the effects of variables upon possibilities for cooperation. Indeed, this is the case.

For a first comparison, rewrite Equation 4 as

$$F(\lambda) = \delta \geq \frac{\lambda(\alpha - 1 - \beta) + \beta}{\lambda(1 + 2\beta + \alpha) - (\alpha + \beta)}.$$

What we need to understand is how the level of λ affects the level of δ necessary for cooperation. We obtain this result by taking the derivative of Equation 4 with respect to λ.

Taking the derivative of Equation 4 with respect to λ allows us to determine the impact of information upon the necessary discount level in order to obtain cooperation. We note that

$$F'(\lambda) = \frac{\alpha^2 + \alpha(\beta - 1) + \beta^2}{[\lambda(1 + 2\beta + \alpha) - (\alpha + \beta)]^2}.$$

Because the denominator is positive, the numerator determines the sign of $F'(\lambda)$. Due to the minus sign in the equation, we must find the sign of the numerator. If

$$\alpha^2 + \alpha(\beta - 1) + \beta^2$$

is negative, then the derivative is positive; otherwise it is negative. It can be shown that there is no combination of $\beta>0$ and $\alpha>1$ that will yield a negative value for the numerator, so for $\alpha>1$ and $\beta>0$, $F'(\lambda) < 0$.[38] This result is expected. It implies that *as the level of information increases, the discount factor need not be as large in order for cooperation to be sustained*. Likewise, *as the level of information decreases, the discount factor must increase in order for cooperation to be possible*.

It is also important to determine how factors of the business, or game, affect the suitable levels of information for cooperation. Here rewrite Equation 3 as a function of these variables:

$$G(\alpha,\beta,\delta) = \lambda \geq [\delta\alpha + \beta + \delta\beta]/[1 + \delta + \beta + 2\delta\beta + \delta\alpha - \alpha]$$

[38] See appendix B for details.

By finding the derivatives, we can determine how these variables dictate the required λ level necessary for cooperation.

First, to determine the impact of rewards from cheating upon the prospects for cooperation, we compute

$$\frac{\partial G}{\partial \alpha} = \frac{\beta\left(\delta^2 + \delta + 1\right) + \delta + \delta^2}{\left(1 + \delta + \beta + 2\delta\beta + \delta\alpha - \alpha\right)^2} > 0 .$$

This partial derivative is positive because the numerator and the denominator are positive. The positive derivative means that an increase in α will increase the G value, so the lower bound on the necessary value for λ becomes larger. This means that *an increase in the rewards from cheating must be compensated by an increase in the level of information in order for the society to sustain cooperation.*

In order to assess the impact of the loss borne by being cheated upon the level of information necessary, we compute

$$\frac{\partial G}{\partial \beta} = \frac{\alpha\left(\delta^2 + \delta + 1\right) - \left(\delta^2 + 2\delta + 1\right)}{\left(1 + \delta + \beta + 2\delta\beta + \delta\alpha - \alpha\right)^2} .$$

Again, the sign of this partial is determined by the sign of the numerator. The numerator is positive when

$$\alpha\left(\delta^2+\delta+1\right)>\left(\delta^2+2\delta+1\right)$$

or when

$$\alpha > \frac{\delta^2+2\delta+1}{\delta^2+\delta+1} > 1 .$$

The fraction bounding α and 1 is always greater than one because the numerator is larger than the denominator. *When α and β satisfy this inequality, then an increase in β must be compensated by an increase in the level of λ in order to ensure cooperation.*

It is also possible, however, to have values for α and δ such that

$$\frac{\delta^2+2\delta+1}{\delta^2+\delta+1} > \alpha > 1.$$

When this occurs, the partial is negative. This means that *when the rewards for cheating are small enough relative to the discount factor, then an increase in the cost of being cheated, β, actually allows more flexibility in the required level of λ to achieve cooperation.*

To appreciate the significance of the two possibilities for the partial with respect to β, note that any $\alpha < 4/3$ satisfies the last inequality, so it gives a negative value for the partial derivative $\frac{\partial G}{\partial \beta}$. If δ is large (close to 1), then for α values from 1 to close to 4/3, the effect of an increase in the cost of being cheated actually makes the society more willing to cooperate. In other words, we obtain a setting in which the combination of limited returns from cheating (the value for α) plus a strong acceptance of the importance of the future (a δ close to 1) combine to create a setting where the cost of being cheated (the value for β) actually lowers the λ information requirements needed for cooperation. This society has more flexibility. It must be noted that this result depends on the value of the discount factor. If the discount factor is low, then the bounds on α also decrease. In this type of society, a small reward but large penalty provides a slight cooperative effect. But once the reward is large enough, then an increase in the penalty requires an increase in the value of λ.

Note that if the discount factor is sufficiently high, we encounter a situation in which a change in the value for cheating can abruptly change the effect of the variable β on the necessary level of λ from negative to positive. This result is new; it identifies a bifurcation point. The existence of this point has interesting implications for our conceptions of rewards and punishments. Namely, the results imply that rewards and punishments are closely related. If the reward for cheating unilaterally is high, then the penalty for being cheated must be low in order to avoid hampering cooperation possibilities. Additionally, the discount factor is significant in maintaining cooperation. If δ is very low, then achieving cooperation will be very difficult.

Finally, we wish to assess the impact of the discount factor upon the level of cooperation needed.

$$\frac{\partial G}{\partial \delta} = \frac{\alpha(1-\alpha) - \beta^2 - \alpha\beta}{(1+\delta+\beta+2\delta\beta+\delta\alpha-\alpha)^2} < 0 .$$

The value of the partial derivative is negative as a direct consequence of the fact that α>1. *An increase in the discount factor decreases the amount of information needed for cooperation.* Given the result for $F'(\lambda)$, this result is also expected.

The impact of this new model which incorporates the variable λ is that we are now able to capture a more general aspect of how factors such as information, rewards, penalties, discount factors, size, ethnic traits, or kinship can affect outcomes. Through this model, we arrive at a means of identifying when it may be possible to achieve cooperation informally, in the absence of enforcement institutions. Frequently, game theory models only structural aspects of a situation, whereas factors such as culture are left out of the explanation as exogenous variables, or only included as a discount factor. This model not only makes the variables endogenous, but it also allows us to determine their effects upon the possibilities for cooperation. By incorporating the variables in λ into the model, game theory provides valuable insight into why groups which are structurally similar may behave in different ways.

Mechanisms

The previous section explains how groups which descend from similar economic and political systems could institute radically different strategies to cope with their lack of enforcement systems, and it identifies some factors that may motivate these decisions. We recognise that if λ is large enough, then self-policing mechanisms are possible. There may also be multiple Nash equilibria, some involving Cheating and some not.

We know from the model that if λ is too low, then informal mechanisms fail, and cooperation cannot be maintained without external enforcement. In those environments in which the equilibrium is to play Cheat, there is a loss of income.

Yet, intuition and experience tell us that most people will be unsatisfied remaining indefinitely at the Cheat/Cheat Nash equilibrium; and they may attempt to devise means to acquire gains from trade. Russians, for instance, continue to engage in business activity, despite their unfavorable circumstances. We know that self-policing mechanisms will not function in such a society, and we further know that credible judicial and enforcement systems are unavailable. This suggests that, in response, there may be attempts to change the ground rules. Stated in another way, what surrogate mechanisms, intended to fill the gap of legal institutions, will be developed to avoid the loss of trade?

From most indications, Russia's answer to the problem seems to be painful: we see a rise of the mafia and of the use of extortion. Knowing that people have an incentive to cheat, some businesses or individuals choose to use groups who will collect money for them. These security groups arise to fill the vacuum caused by the inability of the state to provide an appropriate arena for enforcement and justice. Are these groups helpful in enforcing contracts, or are they simply making a bad situation worse? Or is this a stage in a slower evolution toward civil society?

Milgrom, North, and Weingast provide another potential explanation for this question. Initially, they model the development of institutions as a way of overcoming the problems of anonymity in a larger community. To do so, they create an independent third party, a judge or actor, who will hold information about the players and who will resolve disputes. They call this actor the Law Merchant (LM).

The model they develop is an extended stage game in which players can decide to pay a certain amount to investigate the reputation of their current trading partner. Then the two players play the game. If the outcome is not to a player's liking, the player may appeal to the LM, but *only if* he has queried the LM at the beginning. If either player appeals, then the LM awards a judgment, J, to the plaintiff if he has been honest and his player has cheated; otherwise, no judgment is awarded. If a judgment is made, the guilty party may pay it at a certain personal cost, or he may refuse to pay it at no cost. Any unpaid judgments become part of a permanent record.[39]

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[39] Milgrom, North, and Weingast, 1990, p. 11.

The authors demonstrate that this sequence (they call it the Law Merchant System Strategy, LMSS) can be a symmetric sequential equilibrium strategy. In order to do so, they show that players can gain if they play Honest. They further show that it pays to pay judgments if a defendant has cheated. They additionally show that it does not pay to play Cheat even in a one period deviation; and that it pays to query the LM if the player does not have an outstanding judgment.[40] If these conditions are met, then players will believe that other players are also following the strategy, and thus they will follow the strategy as well. This is because to deviate from the strategy in this case would be more costly. In this way, the authors demonstrate that an institution can restore cooperation even when the players know little about each others' reputations and histories.[41]

The LMSS model provides insight about the role of institutions in creating the opportunities for cooperation when informal mechanisms cannot sustain it (λ is low). However, for our purposes, it does not explain the rise of extortion in places like Russia. To explain extortion - how it came about and what it achieves - another model is created and introduced here.

Extortion:

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[40] ibid, pp. 12-14.
[41] See ibid pp. 11-15 for details.

In countries that have credible judicial and enforcement systems, institutions are used to enforce contracts. These institutions function by penalising cheaters and compensating the honest players who have been cheated. If the penalties are high enough, then both parties to an agreement have an incentive to behave honestly.

If, in a society that does not enjoy a credible enforcement system, λ is insufficient to sustain cooperation on an informal basis, then some surrogate institution will be necessary in order to conduct trade. The motivation and nature of this game is to capture a simplified version of extortionist behavior in Russia. In this model, we assume that an extortionist charges his client a fee, C, at each stage of the game.[42] The player plays the prisoner's dilemma with an opponent. If both players play Honest, then the payoff is 1 minus the fee, C. If one player cheats, the other player's extortionist penalizes that player an amount $J > \alpha$. The honest party will receive $P<J$ in compensation ($P-\beta>0$). The extortionist keeps J-P of the penalty. If both players cheat, then neither is penalised.

B_c

[42] Note here that the C's need not be equal for players B_r and B_c, they must simply satisfy the specified inequalities. This flexibility allows the model to capture the situation where different extortionists charge different fees. In general, for the client to accept the services, $C < 1$.

B_r	Honest	Cheat
Honest	1-C, 1-C	$-\beta$-C+P, α-C-J
Cheat	α-C-J, $-\beta$-C+P	0-C, 0-C

Figure 4 -- Extortion Model

An important point to note is that, through this system of fees and penalties, the extortionists create a situation in which it is now a Nash equilibrium for both players to play Honest. Each player has a dominant strategy to play Honest, because $1-C > \alpha-C-J$ and $P-\beta>0$. In other words, in a manner similar to the function of the Law Merchant, by changing the payoffs for the players, *the extortionists fill the role of an institution* in maintaining the prospects for fair trade.

The surprise is that if both players use enforcers, cooperation can become possible. But, what happens should one of the players refuse the offered services of an extortionist? If only one player has an extortionist, the game is somewhat different.

	Honest	Cheat
Honest	1-C, 1	-β-C+P, α-J
Cheat	α-C, -β	0-C, 0

Figure 5 -- One Extortionist Model

In this game, the players no longer have a dominant strategy. For the player with

an extortionist, 1-C < α-C, but since P>β, then 0-C < -β-C+P. The player without the extortionist also has no dominant strategy, because 1 > α-J but -β<0.

In this circumstance, neither player would wish to play a pure strategy because of the danger that the other could second-guess him or her. Thus, both players would do better by using mixed strategies[43] that randomize their actions. If player 1 chooses between his strategies with a probability z of playing Honest, in such a way that player 2 is indifferent between her two strategies, then the probability will be

[43] Here, mixed strategies can also be seen in terms of numbers of people in a given population who are likely to take a certain action. This idea is drawn from Davenport (1960).

$$z = \frac{\beta}{1+\beta-\alpha+J}$$

Given its probability, the player without the extortionist can expect to obtain $\frac{\beta(\alpha-J)}{1+\beta-\alpha+J}$ using either strategy. But, since J>α, we know that the numerator of this payoff is negative. For the same reason, we know that the denominator is positive, so the player without the extortionist expects to lose when matched with someone who does have one. In this setting, it is profitable to have an extortionist.

If player 2 chooses a probability of playing Honest such that player 1 will be indifferent between strategies, then that probability for the mixed strategies will be

$$q = \frac{P-\beta}{P+\alpha-1-\beta}.$$

With this probability, player 1 can expect to gain $\frac{\alpha(P-\beta)}{P+\alpha-1-\beta} - C$.

We know that P>β and that α>1, and so we know that the denominator is smaller than the numerator, making the fraction larger than one. Depending on the value of C, if C is not larger than the fraction, this number would be positive. So for certain ranges of fees, the player who has an extortionist tends to do better than the player without one. If this is the case, then the player without one would have an incentive to hire an extortionist, as he would do better.

If we examine this issue in terms of an institution, the results make sense, intuitively. The goal of an institution, such as a court, is to provide equal treatment under the law. If one player receives unequal treatment, it stands to reason that that player would be hurt.

There is one other player to consider in this situation. That is the extortionist himself. Does it make sense to fill this role? It does. If information regarding the presence or absence of an extortionist is perfect, then both players, in a game in which both players have extortionists, will recognize which strategy is dominant, and the extortionist will be able to collect fees costlessly. The only cases in which action will be necessary would be if the opponent does not have the protection of an extortionist, but even those cases provide incentives for others to obtain that protection, reducing the numbers who will be alone in the future.[44]

In fact, part of the problem is that it is profitable to be an extortionist. Individuals have incentives to provide, and even obligate people to accept, these services. This incentive system can be troublesome for many reasons. First, the extortionists have an incentive to charge the

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[44] This implies an n-person game.

highest fee possible without giving the businessman incentive to go out of business. This practice not only reduces the incomes of the population in business, but also leaves less income available for taxation, reducing the national income. (This problem is made worse if we also recognize that many extortionists do not pay income tax to the state on their "earnings.")

Second, there is no official regulation on the penalties imposed by extortionists on cheaters. This means that penalties may range from threats to murder for similar offences. Third, many people find that, because the incentives to provide these "protection services" are so great, they have no choice as to whether or not they wish to accept and pay for the services. The services and fees are imposed upon them. For all of these reasons, business activity may become hampered due to the presence and need for extortionists.

Both domestic and foreign business men and women may be deterred from entering the business market in such an area. This further hurts the area's economy. Thus, although extortion can fill the role of an institution, in certain cases where such institutions are lacking, it is an imperfect institution at best. Instead of providing a basis for stable trade, the presence and use of extortion can lead to the deterioration of the economy.

The above model can be seen as one possible outcome of the repeated prisoners' dilemma game, in which N different people interact with one another randomly. The Folk Theorem tells us that there are many potential paths and outcomes to the game. The significance of this model is that it was patterned on reality and that it yields an outcome that, to many, may appear counterintuitive. In an environment of corruption and chaos, we might believe that the presence of extortion would only further confuse and complicate business interactions. The model shows that, to the contrary, the presence of extortion can serve to fill the role of an institution - the role of the absent legal system - and can provide a means of avoiding the "trap" of the prisoners' dilemma, but that it does so at a loss.

The next natural question is to wonder why extortion does not appear in the sufficient-information world described in the model in Equation 3. After all, if extortion is profitable, then what precludes extortionists from trying to "do business" in every society?

In order to answer this question, the extortion model can be combined with the information model. In combining the models, the society used is one of sufficient information - where enough people know what others have done in the past. Recalling the structure of the two models, it can be shown that as δ becomes large (close to 1),[45] then at some point it

[45] Recall that the ATFT strategy will be ineffective if δ is very small.

will be better for players to refuse the offers of extortionists and to play on their own.

To obtain a sense of how this conclusion is reached, recall that if a player uses the services of an extortionist, that player pays C at each stage of the game and gains 1 in trade. In a society with sufficient information (large enough λ), the same player can gain the payoff 1 without paying a fee simply by playing ATFT. So the use of an extortionist imposes a loss of C every period.

We may further imagine that if the player refuses an extortionist, then he or she will take a punishment P, P>1>C, for k periods. Thus, a person from a society in which there is perfect information is essentially comparing the payoffs of 1, which he or she would gain from cooperation, minus the penalty P for k periods and then receiving 1 forever,[46] with the payoff of 1 minus the cost C forever. For some δ, there will be a point at which it is better to pay a non-permanent penalty than a permanent fee,

$$\{1-P + \delta(1-P) +\ldots+ \delta^{k}(1-P) + \delta^{k+1}1 +\ldots\} \geq \{1-C + \delta(1-C) +\ldots+ \delta^{k}(1-C) + \delta^{k+1}(1-C) +\ldots\}.$$

[46] In the case of finitely lived beings, this would be receiving a payoff of 1 for the rest of one's life.

or

$$(1-P)\left(\frac{1-\delta^{k+1}}{1-\delta}\right)+\delta^{k+1}\left(\frac{1}{1-\delta}\right)\geq(1-C)\left(\frac{1}{1-\delta}\right).$$

From this computation, we may deduce that in a society with sufficient information that does not place too much emphasis on the present, informal mechanisms can sustain cooperation without the need for formal or surrogate mechanisms, and extortion will not be able to gain the foothold that it does in a society without these features. The model provides some intuition for how and when extortion may become useless as an institution, and for when it will die off. This computation provides some insight as to how and why extortion is no longer frequently used in Estonia.

Summary

The importance of the results may not be immediately obvious. The Folk Theorem tells us that multiple paths and outcomes are possible in a repeated prisoners' dilemma game, but it does not give any indication of which strategies or outcomes are most likely to be used in which circumstances. This analysis shows that variables such as information, size, discount factors, and other factors could play a large role in determining the path. Moreover, when we incorporate the variables into our model, we may be able to predict what outcomes and strategies will occur in which environments. This possibility could be helpful in providing more concrete answers, rather than the incomplete response given by the Folk Theorem.

In particular, the basic conclusions from a setting of sufficient information are as follows:

1. An increase in the level of information in a given society decreases the constraints on the size of the discount factor necessary for cooperation. Similarly, a decrease in the level of information increases the necessary size of the discount factor.
2. An increase in the rewards from cheating necessitates an increase in the level of information in order for the society to sustain cooperation. A decrease in the rewards reduces the necessary level of information.
3. A bifurcation point exists for the effect of the magnitude of the penalty for being cheated, β on the necessary level of information - $\frac{\partial G}{\partial \beta}$. There exists a critical point, cp, such that if the rewards for cheating, α, are smaller than cp, and the discount factor is high, then an increase in the cost of being cheated allows more freedom in the level of information

needed to achieve cooperation. If α is larger than cp, then an increase in the cost of being cheated increases the level of information necessary.

4. An increase in the discount factor allows more freedom in the amount of information necessary. A decrease in the discount factor increases the necessary level of information for cooperation.

However, if λ is not sufficiently large to sustain cooperation, then we may refer to the model for extortion. Here the basic results are:

1. If both players use the services of extortionists, then Honest is a dominant strategy for both and cooperation is a Nash equilibrium.
2. If only one player hires an extortionist, then that player, on average, does better than the player without, and the player without has an incentive to hire his or her own protector.

Taking the models together, we can begin to understand why it is possible for two places, which started under similar circumstances, to have chosen such different paths. In making the models as realistic as possible, we can see reasons behind the different strategies used in the different countries.

From the above analysis, we can also gain a greater understanding of why extortion has emerged in Russia. First of all, the absence of a strong, credible judicial system has created a need for some sort of institution to provide contract enforcement. Because the Russian community is so large, it cannot rely on reputation and information effects that a smaller society, such as Estonia, can profit from. Also, because of other variables, such as a tendency in the community to place a great deal of emphasis on the present, even small towns cannot make efficient use of their size to encourage cooperation. Thus, without some form of institution, cooperation would be very difficult, or even impossible.

In the absence of the information available in a small community, there are, unfortunately, incentives for groups to profit by providing enforcement services. The model shows that groups can gain by setting their costs as high as the market will bear. The groups deter cheating by setting the penalties too high for players to wish to risk paying them. In this way, extortionists can make their services necessary, without having to cut the prices they charge for them.

Thus, we can see that in the absence of credible judicial and enforcement systems, if the size of the community is large, or in some other way the information available to the community members about one another's actions is low, or if the discount factor is small, institutions will be necessary to make cooperation possible. However, the institutions need not be benevolent, as is the one demonstrated by Milgrom, North, and Weingast. In fact, the situation leaves several incentives for groups to gain from the situation at the cost of others.

What does this analysis tell us about the impact of a judicial system on market operations? Without a judicial system, businesses in larger countries will need some form of institution to enforce contracts. If the state is not willing or able to step in and provide these services through a legal framework, then other groups may be only too willing to take over the responsibilities themselves. The result could be a severe loss of income to the state.

In conclusion, the above analysis does not and cannot claim to provide a complete explanation for the changes and differences observed in Russia and Estonia. Instead, the significance of this work is that it demonstrates how a simple model and its extension can provide valuable insight in explaining the relevance of factors in various different problems. Through the factors highlighted in the model, we can obtain a better idea of what factors to examine in our study of these countries and their transitions towards a market economy.

Part 2

Control and the Collective Action Problem

K. Saari-Sieberg

The previous section applied variations of the Collective Action Problem, in the form of the Prisoners' Dilemma game, to examine the phenomenon of cooperation and cheating in environments which lacked formal judicial and enforcement systems. This section uses a similar approach - applications of variations of the Collective Action Problem - to address a different problem, that of one group's control over another. As in the previous section, Estonia and the Soviet Union will be used as a case study, but the goal of this work is to develop a model that is applicable to other situations.

From the continual reports of struggles in Chechnya, Israel, Northern Ireland, and Indonesia, to name only a few, problems related to the control of one group over another are contemporary and recurrent. Clearly, the lack of resolution to these problems signals that strategies have not been clearly formulated for either side of the conflict.

Olson also examines the issue of control in the form of annexation (Olson, 1995) and contends that in the case of a stronger nation overtaking a weaker one, emotions, such as patriotism, and the instinct for individual self preservation may run into conflict. In this case, the inhabitants of the threatened nation confront a free-rider problem. The result of this large scale Prisoners' Dilemma may be that a majority of the citizens fail to provide resistance to the conquering regime.

Olson's premise in this context is intuitive. When we take into account the relative gains and losses of actions to individuals, his equation of the dilemma facing the smaller country with a collective action problem is straightforward.

> If...an individual makes a sacrifice to rebel against the regime that he despises, he will bear the full cost and risk of whatever he does to help overthrow the hated regime. Yet any benefits of what he does will automatically go to people throughout the society, whether they made any sacrifices to help overthrow the hated regime or not. Each typical individual who acts to overthrow a bad government gets only an infinitesimally small share of the benefits from any success.[47]

It is very simple to model the choices of individuals with a Prisoners' Dilemma game, to demonstrate the enormous constraints that self-preservation placed upon their decisions.

If we believe Olson, then we have a simple explanation for why the Estonians initially allowed the Soviet army into their country without any real resistance. However, history later provides us with a puzzle. With the Soviet army firmly in place in the tiny nation of Estonia, a

[47] Olson, 1990, pp. 10-1.

resistance movement organized and gained some power. This occurrence is difficult to reconcile with the enormity of the collective action problem faced by the Estonian people; in fact, it is directly counter to the actions that one would normally expect to observe, given such a setting. The case suggests that either our use of the collective action problem is inappropriate to describe situations of control, or else that there are other factors involved that may otherwise influence outcomes. The intent of this section is to examine this issue.

Background

In the context of this discussion, it is important to note that there was more at stake for the tiny country of Estonia than loss of sovereignty. Through annexation of nations, other groups found themselves forced to experience the restraints, disincentives, and difficulties created by the Soviet government's experiment with a Communist political and economic system. Estonia's own loss, derived from forced adoption of this system, was substantial. This section will briefly describe the background of Estonia during independence 1918-1939 as well as the years of occupation, 1940-1991.

The Republic of Estonia has had a history of being conquered and administered by a number of geopolitical powers. The nation and the people have endured for the past 5000 years, despite the ambitions of the Mongols, Teutonic Knights, Danes, Germans, Swedes, Poles, Russians, and even a Georgian named Stalin.[48] During 700 years of control by the Baltic Germans, the Estonian people endured the position of being the underclass in their own country, subordinate to a people whose affinity was towards another country, Germany, that many of them had never even seen. As various nations ruled Estonia, the rulers competed for the loyalty of the locals, allowing many Estonians to rise from the status of serf or peasant, to become educated, and to become a contributing part of intellectual and political society.[49]

As Estonia began to grow after 1861, the Estonian people became more assertive of themselves culturally. The industrialization of Estonia and the creation of an Estonian bourgeoisie and intelligentsia led to the formation of and awareness of economic self-sufficiency. In 1905, Estonians owned three quarters of all real estate values under 5000 rubles, and a third of those above this value.[50] As Baltic German control

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[48] Sieberg, Erik T., p. 4.
[49] Taagepera, 1993, chapter 2.
[50] Raun, p. 91.

diminished, Estonians achieved a greater role in their society and began to push for an opportunity to expand their control.

The First World War provided this opportunity. With the defeat of Germany, and with Russian politics in disarray, the Estonian people seized the chance to establish their own nation state. On the 24th of February, 1918, Estonia declared independence after 700 years of Baltic German control, 200 years of Tsarist rule and one year of Bolshevik rule. After a war against the Bolsheviks and the German Landeswehr, independence was achieved.

The period of independence was brief, but it allowed the Estonians to finally control their own country. The period is important, because it suggests that Estonia could be significantly more developed today, politically and economically, had it escaped global and regional turmoil.

The Estonians initially had a democratic government. As communism and fascism spread through Europe, however, these ideas began to take root among some in Estonia as well. Factions in the government began to press for power in order to implement their ideologies. In an attempt to thwart a fascist takeover of government, President Päts seized control of the government and implemented authoritarianism. In later years, as the threat subsided, Päts relaxed the government, returning to democracy.[51] The Republic of Estonia was illegally annexed by the Soviet Union in 1940.

To Fight or Not To Fight

Establishing Control

Let's return to the issues facing opposing groups in order to make the problem more precise. Olson's insight regarding the existence of a collective action problem appears intuitive. Without much debate, it is reasonable to expect that if such a scenario does occur, then this lack of resistance facilitates the task of the stronger group to control the weaker group. However, rather than immediately accepting Olson's insight, it is instructive to understand the kind of actions that could evolve within and between the opposing groups.

The analysis presented here focuses on evolving, rather than repeated games. The actions taken by members of the opposing groups

[51] Taagepera, 1993, pp. 49-58.

serve to change the game, altering the payoffs and also the corresponding strategies of the players. The strategies of the controlling group are not explicitly modelled. International relations literature informs us that the decisions of a controlling group are influenced by numerous sources, including domestic and international pressures, and bureaucratic pull.[52] The effect of these many and often conflicting pressures is that strategies of the controlling group can be difficult to model in any predictive manner. Instead, a more productive approach is to examine potential actions that could be taken by a controlling group. Through this approach, we can understand how these actions, or, similarly, how actions taken by a weaker group, can produce changes in the game, and how these changes affect outcomes and subsequent strategies of the weaker group in terms of collaboration or resistance.

Imagine the worst case scenario for the occupier. A legitimate fear of the occupier is that some members of the conquered nation may wish to cooperate with one another to the detriment of the controlling regime. If this is indeed the case, then the potential strategic choices with payoffs to members of the resisting group would assume the form:

[52] Examples include Putnam, "Diplomacy and Domestic Politics," 1988, Schelling, 1960, and Keohane and Nye, 1989.

		Player 2	
		Cooperate	Betray
Player 1	Cooperate	4,4	1,3
	Betray	3,1	2,2

Figure 6 -- Harmony

In this game[53], the two players are both members of the weaker (controlled) group. The options of each member are to either Cooperate with or Betray a fellow member. Since, with this simple setting, the fellow member will select one of the two strategies, we end up with the four options represented in the payoff matrix. Their payoffs represent the differential outcomes dependent upon their own actions as well of those of fellow members of the group. It is important to note that the numbers are mainly symbolic. For simplicity of later analysis, the numbers are cardinal, however, they generally serve to represent the ordinal ranking of outcomes among the players.

Our first setting is one in which there are no external controls over the members of the weaker group. Consequently, because this matrix represents the controlling group's worst case scenario, we must expect the

[53] Rousseau refers to this game as the Stag Hunt.

rankings to assume the following form: An individual receives his or her highest payoff, 4, by helping a fellow countryman or group member. That person's second-best outcome, represented by a payoff of 3, is if he or she Betrays without being Betrayed. The next best outcome is if both Betray each other, and the worst outcome is to be Betrayed while Cooperating. If this matrix applies to a group, then we can expect the members to choose the Pareto superior Nash point of Cooperating[54].

Such a situation would undermine, to at least some extent, the control of the new regime. If members of the weaker group are willing to cooperate with one another, then we can imagine that they could pose a risk to the controlling group - particularly if that group wishes to effect changes that are not consistent with the desires of the weaker group. If this is the case, the controlling group may find itself facing three options: abandon efforts, fight the group, or in some manner attempt to alter the payoffs of the weaker group so that they would be less likely to resist changes.

All three actions have been used in the past, and all three are valid options. The last strategy merits closer inspection. Why would a group seek to alter the payoffs of the opposing group? As we recall from Olson, the existence of a collective action problem in a group limits the

[54] There are two pure strategy Nash equilibria, Cooperate/Cooperate and Betray/Betray. The first is Pareto superior to the second.

ability - at least in the short run - of that group to take action, despite the potential benefits such action might entail. Borrowing from this intuition, if a collective action problem could be created in the weaker group, then the controlling group could institute changes with minimal opposition.

If the controlling group does choose to follow this third option, then we may reconstruct the game facing the weaker group. If a collective action problem is to be created, then the controlling group must destroy the incentives for members in the weaker group to Cooperate with one another. In terms of payoffs, this alteration may be effected by making it more costly to Cooperate and/or more rewarding to Betray. We can imagine that the controlling group could produce this effect through the use of punishment for Cooperation and/or rewards for Betrayal.

If individuals who refuse to Betray others can be singled out, then the controlling group can punish them. Rather than a blind system of rewards and punishments, we might imagine that the controlling group would treat individuals differently, according to their circumstances. In this way, those who Cooperated with one another would be penalized a random amount, which, when accompanied by the likelihood of such a penalty, creates the expected penalty of ϕ, reducing their expected payoff of joint cooperation from 4 to $4-\phi$. The penalty to a Cooperator who was Betrayed by his countryman might be different, reducing his payoff from 1 to $-Z$.

Similarly, the Betrayer of this person could be rewarded for his or her actions, raising his payoff from 3 to 4. For those who Betrayed one another, they may each expect to be penalized, reducing their payoff from 2 to $-\psi$.[55]

	Cooperate	Betray
Cooperate	$4-\phi$, $4-\phi$	$-Z$, 4
Betray	4, $-Z$	$-\psi$, $-\psi$

Figure 7 -- Punishment/Reward Model

Recall that the purpose behind the addition of punishments and rewards is to create a collective action problem within the weaker group. To be effective, the regime should ensure that the rewards for Cooperation are not as strong as those for Betraying a cooperative person. The numbers in the matrix are purposely chosen to aid the analysis, because this state of affairs is true as long as

$$4-\phi < 4,$$

[55] Note here that the relative values of the payoffs are not specified. This was done purposefully to allow for variation and flexibility in the actions of a controlling group. The effects of these variations will be made clear.

or whenever $\phi > 0$. Thus, the Cooperate/Cooperate cell is no longer a Nash equilibrium. The values for Z and ψ determine whether the game is a Prisoners' Dilemma or Chicken. If Z is larger than ψ, then the game is a Prisoners' Dilemma, if it is smaller, then the game is Chicken.

Will this simple adjustment in payoffs transform a world of cooperation into an Orwellian system of betrayal? An initial examination of the game indicates that this is possible. Note that, since both players have a dominant strategy to Betray, the Nash equilibrium for the Prisoners' Dilemma is mutual Betrayal. Although we saw in the previous section that, given sufficient levels of information in a community (if λ is high enough), it is possible to avoid the Pareto inferior Nash equilibrium in a Prisoners' Dilemma, the associated requirements to acquire a large enough λ value involve creating a community of trust that are so demanding in this setting that we can expect players to obey their dominant strategies at least in the short term.

Furthermore, if a controlling group is aware that information flows can undermine their hold on a community, then we would expect that group to take measures to limit the amount of information available. These actions would serve to limit the knowledge of who has cooperated within the group, by refusing to Betray his or her fellow countrymen, in the past.[56]

In Chicken, neither player has a dominant strategy, however, the Nash equilibria are Betray/Cooperate and Cooperate/Betray. The worst payoffs are received from mutual Betrayal, however, a player's best payoff arises from unilateral Betrayal of another. Thus, each player has some incentive to Betray another. So merely by altering the payoffs through a system of punishment and reward, a controlling group can achieve a situation in which many of the controlled will strive to collaborate with the leaders at the expense of one another.

This model is, at best, an extremely simplified representation of the actions a controlling group can take in order to decrease resistance and opposition. What adds particular interest is that, however limited, the model does bear a close resemblance to the actions taken by the Soviets to quell Estonian resistance. The model specifies that the occupying force can deter fighting by setting the level of punishment very high. The Soviets followed this strategy. Because any person who acted out against the Soviets believed that he or she would be subject to punishment, the

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[56] As shown in the previous section, the effect of this control would be to destroy the possibility of an ATFT equilibrium, in which, if information is good (or perfect), it can be an equilibrium for members of a community to cooperate with a player who has played according to his or her ATFT strategy in the past. The strategy can lead to cooperation in a community.

incentive to fight was decreased. And Soviet punishment for resistance was swift and brutal. In the fall of 1940, the majority of Estonia's government leaders, public figures, and members of the military were arrested. In 1940 and 41, Soviets arrested more than 7,000 Estonians. Systematic executions began in 1941. Estonia lost more than 60,000 of its people (6 percent of the population) to executions, deportations, and exile in the period of one year. Less than one third of those people deported survived to return.[57] The risks associated with action against the Soviets were so great that the incentives to collaborate, if unwillingly, were greater.

The Soviets additionally took steps that correspond with the model's suggestion to limit information flows among the weaker group. The Soviets provided incentives or forced Russians and Russian Estonians to relocate in Estonia.[58] These groups held loyalties to the Soviet Union and effectively served as a civilian garrison, preventing Estonian organization. Religious organizations were silenced and infiltrated.[59] All forms of media were strongly censored. Listening to foreign radio or receiving mail from abroad was punishable. History was falsified, presenting Soviets as Estonia's "saviors."[60] Phone lines were tapped. All of

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[57] Laar, 1992, pp. 8-9.
[58] Taagepera, 1993, pp. 83-4.
[59] Taagepera, 1993, p. 85.
[60] Taagepera, 1993, p. 87.

these steps aided the Soviets in reducing the level of information that passed among the Estonians.

Partial Resistance

The previous section demonstrated that even in a group which experienced full cooperation with one another, a collective action problem could be imposed, given the proper application of punishments and rewards. Through the use of comparative statics, this section offers a more precise description of the effects of levels of punishment upon the compliance of the group.

To achieve a more specific concept of the actual compliance of a group, we can extend our notion of strategies from *discrete* strategies to *continuous* strategies. The impact of this change is that we no longer assume that individuals select from pure strategies (Cooperate or Betray), but that they take actions that are somewhere between the two extremes. I refer to this mixing of strategies as *partial resistance*.

This extension allows for the possibility for a player to collaborate as much as necessary (Betray) yet to also take some risks in terms of limited cooperation with others. We would expect that larger levels of punishment would serve as a deterrent for resistant behavior, causing the player to choose his strategy as close as possible to Betray. Likewise, we would expect that lower levels of punishment might give some people incentives to risk Cooperation with one another.

An example of this type of behavior may be drawn from the case study. While many Estonians chose not to participate in active resistance, several selected strategies that lay between the extremes of resistance and collaboration. These strategies could involve minimal resistance, such as knowing the identities and/or locations of resistors without revealing them to the Soviets. Other people adopted higher levels of resistance, supplying food, arms, or even temporary shelter for resistance members.[61] The strategies taken by these people represent neither the extremes of full Cooperation nor of full Betrayal. Rather, the strategies were selected at varying levels between the extremes.

The concept of partial resistance is modelled in the same way as are mixed strategies, but here the mixed strategy results are interpreted in terms of levels of partial resistance chosen by individuals rather than as a randomization process designed to prevent one's opponent from second-guessing which pure strategy will be selected. Under partial resistance, a player may select a pure strategy or some path in between the two extremes of Cooperate and Betray.

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[61] Laar, 1992, p. 70.

In situations of resistance, the actual game is not necessarily one of simple Cooperation or Betrayal - instead, the adopted actions must be replicated over many daily actions that lie between the extremes of Cooperate and Betray. We may view these multiple decisions as n-dimensional. Interpreting these choices as selections on a continuum allows us to consolidate this n-dimensional game into a more simple two-by-two game. To use this approach of collecting all actions into one dimension, we must assume that actions are monotonic - i.e., that if a person is willing to choose partial resistance at a high level, then he is also willing to participate in partial resistance at a lower level.

Again, the application of punishments and rewards have changed the game to the following.

		q	1-q
		Cooperate	Betray
p	Cooperate	$4-\phi, 4-\phi$	$-Z, 4$
1-p	Betray	$4, -Z$	$-\psi, -\psi$

Figure 8 -- Partial Resistance

In this game, the variables p and q are used to denote the expected level of partial resistance. For instance, if p=0, then Player 1 chooses a strategy that places full weight on Betrayal. If p=1, then Player 1 fully Cooperates. Any p between 0 and 1 will represent the selection of a strategy between the two extremes.

As stated above, we would expect the level of punishment to affect a player's choice of p or q. Following the reasoning from the derivation of mixed strategies, Player 2 selects a level of q that makes Player 1 indifferent between the two strategies, so it must be that

$$(4-\phi)q - Z(1-q) = 4q - \psi(1-q),$$

or

$$q = \frac{Z-\psi}{Z-\phi-\psi}.$$

For Player 1 the case is symmetric,

$$p = \frac{Z-\psi}{Z-\phi-\psi}.$$

Comparative statics may now be applied to determine the effect of the level of punishment upon the level of resistance selected. The effect of the level of penalty, Z, for being "Betrayed while Cooperating" (BC) is:

$$\frac{\partial q}{\partial Z} = \frac{1(Z - \phi - \psi) - (Z - \psi)}{(Z - \phi - \psi)^2} = \frac{-\phi}{(Z - \phi - \psi)^2} < 0.$$

This negative value means, as expected, that *an increase in the penalty Z will decrease the level of partial resistance chosen by a given player*.

The effect of the penalty for "mutual Betrayal" (BB) upon the level of partial resistance is:

$$\frac{\partial q}{\partial \psi} = \frac{-1(Z - \phi - \psi) - (-1)(Z - \psi)}{(Z - \phi - \psi)^2} = \frac{\phi}{(Z - \phi - \psi)^2}.$$

As long as $\phi > 0$, this equation indicates that *an increase in mutual penalty will increase the level of resistance selected by a player*. This result has interesting implications - it suggests that adding to the mutual penalty is a counterproductive strategy. On the other hand, weakening this level of punishment can actually decrease the level of Cooperation between members of the weaker group.

Finally, the effect of the level of random punishment for "mutual Cooperation" (CC) upon the level of resistance is:

$$\frac{\partial q}{\partial \phi} = (Z-\psi)(-1)(Z-\psi-\phi)^{-2}(-1) = \frac{(Z-\psi)}{(Z-\psi-\phi)^2}.$$

Depending on the relative level of penalties, this equation shows two possibilities.

If $Z < \psi$, as in the game of Chicken, then $\frac{\partial q}{\partial \phi} < 0$. This means that *an increase in the random level of punishment for mutual cooperation will result in a decrease in partial resistance.*

If, however, the game is a Prisoners' Dilemma and $Z > \psi$, then only pure strategies will be selected, and the Nash equilibrium is Betray/Betray.

Again, the model is extremely simple, yet it is surprising how well the results of the model correspond with the actions and reactions found in the Estonian context. Before comparing these theoretical predictions with historical events, it is worth noting that the different kinds of strategies described above did occur. Passive resistance existed, accompanied by some, infrequent, organized resistance in small groups.

However, as Olson's theory would predict, the groups that were small enough to engage in collective action were too small to serve as a threat to the Soviet government.[62]

Some Estonians were willing to take the risk of action (Cooperation), and were met, as the model prescribes, with harsh punishment. In 1958, a student, Mart Niklus, was sentenced to ten years for sending abroad uncomplimentary pictures of bad construction and a radio jamming station.[63] Later, in 1980, Niklus and an ex-establishment member, Juri Kukk transmitted information to Sweden about the fake nature of Soviet elections and about spontaneous demonstrations on Estonian Independence Day. The two were arrested, given chemical and psychiatric treatments, and finally tried and sentenced illegally. Kukk died two months later.[64]

As the model suggests, those who collaborated with the Soviets and Betrayed other Estonians were well rewarded.

> As a reward for obedience, the Soviet authorities gave their local representatives [collaborators] free rein to steal from and intimidate the families of the "bandits." They hope this would suppress resistance at its source.[65]

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[62] Olson, 1990, p. 13.
[63] Taagepera, 1993, p. 92.
[64] Taagepera, 1993, pp. 113-115.
[65] Laar, 1992, p. 47.

A notebook taken from Soviet security officials contained instructions about how to recruit informers.

> It instructed recruiters to look for poorly educated people and to promise them high-level jobs. The recruit was to be praised in every possible way and his importance emphasized repeatedly. He was to understand the implication that he could do anything he wanted and be protected by the security apparatus. The informers were to be given material aid confiscated from deported households.[66]

Although more research is necessary, the results of the model appear to provide a reasonable explanation for events in the case study.

Individual and Collective Risk

The Soviets added to the collective action problem in another important way. Olson describes the collective action problem as one in which individual action is deterred because the costs of action to the person, in relation to the potential gains that person will share, are too great. In other words, if one million people stand to gain from the actions of a martyr, then that person will gain one millionth of the total but will bear the full cost. In that consideration, most people will not have enough incentive to take the risk.

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[66] Laar, 1992, p. 114.

In the Estonian context (as in other parts of the Soviet Empire), the equation was somewhat altered. If one martyr took a risk in an attempt to overthrow the hated regime, then not only did he bear the cost of his actions, but many of his countrymen also bore the cost as well - through retaliation by the Soviets. This strategy mirrors the prescriptions of the model in terms of increasing the level of punishment to counteract any Cooperation within the opposing group. Due to their greater numbers, the Soviets were more able to wreak revenge on a large number of people. With this prospect, would-be resistors not only had their own welfare and survival to take into account but also those of loved ones and other fellow countrymen.

> Most Forest Brothers [members of the resistance movement] avoided assassinations, knowing that retaliation in the form of mass imprisonments and terrorization of the local population would inevitably follow.[67]

This action increases the impact of the collective action problem - significantly increasing ϕ and Z. In this case, each individual resistor must take into account that not only will he or she only share in, say, one millionth of the total gain - if there is any gain, but also that he or she will bear the full cost *and* many other people will also bear the full cost,

[67] Laar, 1992, p. 96.

without having chosen to undertake the action. With the system of multiple punishments for one crime, those who may have been willing to be martyrs for the cause may have been stopped from this course of action, either by their own unwillingness to harm loved ones or by the fact that those who risked retaliation would stop them before they could attempt to resist. The general population succumbed to Stalinist force and to the ways of life imposed on them.

Decrease in Force

A careful application of punishment and rewards can have the effect of stifling resistance. The results appear to be grim for the hopes of a group that seeks to escape control of another, yet they need not be. First, although increased levels of punishment may decrease partial resistance, it need not be the case that $q = 0$, or that players use no partial resistance whatsoever. The equation merely states that at higher levels of penalty, we would expect to observe lower levels of resistance.

This result is consistent with actions in the Estonian context. The lack of organized dissent did not mean that the Estonians accepted their annexation; it meant that they feared the almost certain punishment for actively voicing this opposition. "During the 50 years when Estonia was unlawfully incorporated into the Soviet Union people never ceased dreaming about the re-establishment of independence."[68] Although open dissent was effectively silenced by Soviet threats, partial resistance, through unorganized dissent, existed throughout the period of Soviet occupation. The dissent was manifested in numerous ways. In response to intense Russification campaigns, Estonian language and character, if anything, became more prominent.

> In the 1979 census, the percentage of Estonians who declared fluency in Russian dropped (from 29 to 24 percent)...There was no concerted campaign in Estonia to understate one's knowledge of Russian, though rumors circulated that an increase in such knowledge could be used as an excuse for reducing Estonian-language book publication.[69]

Many Estonians refused to speak Russian when addressed in that language. Flowers were frequently found on the grave of a hero from the Estonian war of independence - a symbol of nationalist (Estonian, not Soviet) pride, although the man had no living relatives.

A large percentage of international public opinion argues against the severe tactics used by controlling groups. In areas of oppression such as North Korea, South Africa and China, external democratic

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[68] Kallas, Siim, and Mart Sôrg, "Currency Reform," *Transforming the Estonian Economy*, p. 52.
[69] Taagepera, 1993, p. 101. And Roos, p. 54.

governments have put pressure on conquerors to obey human rights doctrines and to cut down on punishments levied upon "dissidents." It is reasonable to believe that the suppressed people would welcome and reward an easing of certain restrictions by becoming more cooperative with the controlling group. This analysis shows that this expectation is not always the case.

Recall that an increase in punishment, in the case of penalty for Cooperation when Betrayed, Z and, in some cases, for mutual Cooperation, ϕ, can lead to a decrease in partial resistance. However, a *decrease in these levels of punishment can result in an increase in resistance*. Restating the results in terms of opportunities for partial resistance, we obtain the following.

1. $\frac{\partial q}{\partial Z} < 0$. A decrease in the level of punishment for "Cooperation when Betrayed" (CB) results in an increase in partial resistance.
2. $\frac{\partial q}{\partial \psi} > 0$. A decrease in the penalty for mutual Betrayal (BB) will decrease partial resistance.
3. $\frac{\partial q}{\partial \phi} < 0$ if $Z < \psi$. A decrease in random punishment for mutual Cooperation (CC) will lead to an increase in partial resistance.

4. $\frac{\partial q}{\partial \phi} > 0$ if $Z > \psi$. A decrease in random punishment for mutual Cooperation (CC) will lead to a decrease in partial resistance.

The results indicate that the decrease in punishment and suffering advocated by Human Rights groups may not produce more peace in a troubled region. Instead, this decrease may spark resistance and increased struggle!

On closer inspection, however, results 1 and 3 are intuitive. We would expect that as the penalty for cooperation decreases, more people who desire resistance against an oppressor would be willing to take the risks associated with this form of action. These results support Olson's beliefs regarding the power of an occupier to control dissent. According to Olson, *perceptions* of power are crucial in stifling resistance.[70] If a group is powerful and is believed to be powerful, as evidenced by its ability to levy sanctions upon dissidents, then, Olson suggests, the collective action problem will persist and individuals will not take the risk of resistance. Once the group's power begins to appear diminished, however, then many will be more willing to risk penalty due to resistance activities, because they believe that this punishment will be less costly to themselves. The results of the equations above indicate that we should, in fact, expect to

[70] Olson, 1990, p. 16.

observe an increase in resistance activity following a decrease in certain levels of punishment.

Olson's descriptions of occurrences in East Germany provide a vivid example of this phenomenon.

> ...then suddenly the regime that was previously so powerful came to have no power at all. Its officials finally did not carry out its instructions. When this happened, the risk of demonstrating against the regime became almost zero. Participating in such a demonstration still cost the participant some time, but that cost was small enough...The unprecedented excitement of participating in these events and the drama of sudden and awesome political change even made participation positively attractive for some.[71]

As the penalty decreased, resistance increased. There are also numerous examples in the case of Estonia that are also consistent with these results. Incrementally, as punishment became less severe, individuals began to take risks. When punishments ebbed, dissent grew. When, in contrast, Moscow cracked down hard, dissent all but vanished.[72]

A vivid example of this trend can be seen in the Estonians' reactions to conscription over time. The Soviets imposed heavy conscription rates on the Estonians. During the years of repression, Estonians were forced into military service, and filled their duties even in the face of perils such as being forced to contend with the Chernobyl

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71 Olson, 1990, pp 17-8.
72 Taagepera, 1993, pp. 116-120.

disaster, as a result of which many Estonians died.[73] As the Soviet regime began to decline, the Estonians began to resist conscription. This resistance was initially unorganized, however, in 1990, the Baltic states were able to halt the conscription of their citizens into the Soviet army with minimal repercussion.[74]

Advances in dissent can be seen from changes in demands made by Estonians over time. During the early years of Soviet control, Estonians dared to ask little from Moscow. In the later years of annexation, the Estonians went so far as to push for the right to implement Western economic systems in their country and for the right to keep their proceeds, rather than transferring them to the Union. In 1987, the "Four-Man Proposal" was written, specifying a plan for economic autonomy in Estonia:

> The Four-Man Proposal recommended that the existing factory-level autonomy principles be applied to Estonia as a whole, including self-financing, self supplying, and self-administration. A territorial balanced budget implied that income and purchasing power of the population would depend "on the demand for our products in the all-Union and worldwide markets."[75]

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[73] Misiunas and Taagepera, p. 286.
[74] Taagepera, 1993, pp. 153&181.
[75] Taagepera, 1993, p.128.

The proposal was a departure from the controlled system of the Soviet Union. It was as close to the Western system of economics and trade that the people dared request. In fact, the authorship of the proposal reflects Olson's collective action problem; the proposal had ten authors, but many of them did not dare to sign it, fearing punishment.[76] The authors admitted that their plan was radical for the time. Several leaders in Moscow criticized it, saying that this sort of republic autonomy was impossible. For many radicals in Estonia, however, the plan did not go far enough.[77]

Both the enormity of the demand and the hesitancy of the authors reflect results from the model. Because punishment had been decreasing over time, some Estonians were willing to take the risk of pressing the Soviet government to take Estonian desires into account. However, since claims of this extent had not been previously advanced, the authors demonstrated an understandable fear regarding the magnitude of the retribution they might receive. The authors were not punished for the proposal.

With a history of fluctuations in control, the certainty of punishment gradually decreased, and the power of the center appeared somewhat diminished. As people realized that there was a chance that they could receive a lower punishment for their acts, they became more willing

[76] Taagepera, 1993, p.128.
[77] Taagepera, 1993, p. 130.

to take chances. As the power of officials weakened further, organization of small resistance groups began.

The significance of these results is that we now have an explanation for why some groups may experience resistance. Frequently, the occurrence of resistance is explained in reference to the suffering of one group at the hands of another. When this suffering becomes unbearable, then, supposedly, the group has little choice but to revolt. These results indicate that, in contrast, in certain cases a *decrease* in suffering may provide an opportunity to revolt.

Potential Errors: The Collective Action Problem Reversed

Drawing from the above analysis, a controlling group might reason that leniency is tantamount to destruction, and that higher penalties are desirable at all costs. It can be shown, however, that reliance upon payoffs created by punishments can be subject to error if not used correctly. Fear can be a motivating factor for collaboration if used accurately, but it can be counterproductive if overused. If an occupying power chooses to demonstrate its power by punishing the subdued group, it could find itself *creating*, rather than destroying, the incentives for resistance. The idea that increased use of force can spark resistance in a group that was previously encumbered by the collective action problem appears counterintuitive until we observe the resulting payoff matrix.

A careful application of punishments and/or rewards can produce a collective action problem. Ruthless use of punishments may alter the game.

	Cooperate	Betray
Cooperate	$4-\phi$, $4-\phi$	$-Z$, $3-\phi$
Betray	$3-\phi$, $-Z$	$-\psi$, $-\psi$

Figure 9 -- Ruthless Punishment Model

In this scenario, an individual risks punishment regardless of his or her actions. Instead of a reward for betrayal of a fellow countryman, an individual risks receiving a random penalty with the expected value of ϕ, reducing the expected payoff to $3-\phi$. As this change in action means that there are no payments to those who "Betray those who Cooperate," the controlling group has altered the payoffs such that

$$4 - \phi \geq 3 - \phi,$$

which is trivially satisfied for all $\phi \geq 0$. Thus, it will be in both players' interests to Cooperate with one another. The Nash equilibrium becomes Cooperate/Cooperate once again. So by asserting too much power in the form of punishments, the interests of the new regime are not served, and may be negated.

The effect of this error in judgment may be demonstrated with a simple graph. Originally, the choice facing many of the people of an occupied nation lies between two undesirable options. The people could choose to collaborate with the occupiers and Betray one another, or they could resist. Resistance is risky. There is a possibility of successful resistance, but there is also the larger possibility that the resistor would be punished. For the purpose of this model, collaboration will be labelled C and is risk free. Resistance, R, is preferable to collaboration, C, but its expected payoff carries the risk of punishment, P, with probability ε. In terms of payoffs, imagine that $R > C > P$. The expected value of collaboration is C. The expected value of resistance is $(1-\varepsilon)R - \varepsilon P$. Any probability ε which is greater than

$$\frac{R-C}{R+P}$$

would be sufficient to induce people to prefer collaboration.[78]

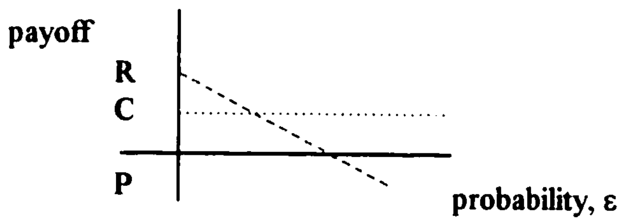

Figure 10 -- Resistance versus Collaboration

Because resistance is initially preferable to collaboration, many people would resist. As the probability of punishment, ε, increases, the choice of collaboration becomes favorable to that of resistance. With this type of situation, the occupier would be able to overcome the nation's members' urge to resist. Although resistance is preferable to collaboration, the risks involved in the strategy of individual resistance could lead the resistor to bear an enormous cost.

[78] To show this, note that a person could receive payoff C with certainty or could receive R with probability (1-ε) or -P (a negative value to depict the value of loss due to punishment) with probability ε. In order for C to be a higher expected payoff, it must be the case that C ≥ (1-ε)R - εP. Solving for ε, we obtain, $\frac{R-C}{R+P} \le \varepsilon$.

By punishing collaborators and resistors alike, the new regime changes the payoff structure, and thus the incentives of the people. The situation is still one in which R > C > P, but now in addition to bearing the risk of punishment for resistance, people also risk punishment for collaboration. The new circumstances facing the population is one in which the strategy of collaboration yields an expected value of $(1-z)C - zP$, where z is the probability of punishment, and the strategy of resistance yields an expected value of $(1-z)R - zP$.[79] Depicting the two strategies on a graph, it becomes clear that resistance is preferable to collaboration for any level of probability, z.

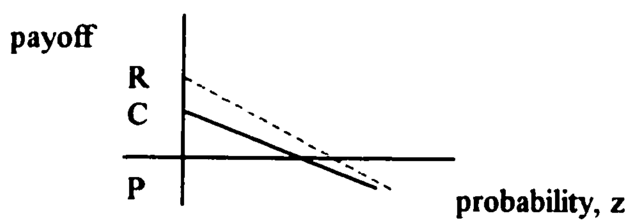

Figure 11 -- Resistance versus Risky Collaboration

Comparative Statics

[79] For simplicity, the probability of punishment, z, and the level of punishment, P, are the same here for collaboration as for punishment. This choice reflects the perception, at the time, that any action was as likely as another to receive punishment. The probabilities could be modified to reflect similar but unequal probabilities of punishment without significantly changing the results.

More rigorously, we may use comparative statics with the Ruthless Punishment model to determine the precise impact of a change in the variables upon the level of partial resistance that we should expect to observe in a given individual. To obtain these computations, it is first necessary to calculate the equation determining the level of partial resistance in this new game. Again, this level is computed by determining when

$$q(4-\phi)-qZ=(1-q)(3-\phi)+(1-q)(-\psi)$$

or

$$q=\frac{3-\phi-\psi}{7-2\phi-Z-\psi}.$$

To determine the effect of the variables upon the choice of partial resistance selected, we may first calculate

$$\frac{\partial q}{\partial Z}=\frac{+1(3-\phi-\psi)}{(7-2\phi-Z-\psi)^{2}}=\frac{3+\phi+\psi}{(7-2\phi-Z-\psi)^{2}}.$$

From this result we note that if the controlling group applies a general level of punishment, $\phi+\psi > -3$, then $\frac{\partial q}{\partial Z} > 0$. What does this tell us? *An increase in penalty for being Betrayed while Cooperating will lead to an increase in partial resistance*. In other words, unlike the original Punishment/Reward model, an increase in penalty here can be counterproductive to the needs of the controlling group.

We may note a similar result for the effect of a change in the penalty for mutual Betrayal upon the level of partial resistance.

$$\frac{\partial q}{\partial \psi} = \frac{-1(7-2\phi-Z-\psi)+(3-\phi-\psi)}{(7-2\phi-Z-\psi)^2} = \frac{-4+\phi+Z}{(7-2\phi-Z-\psi)^2}.$$

In this equation, the level of penalty is important. If the controlling group is punitive, setting the level of punishment high enough so that $\phi+Z > 4$, then $\frac{\partial q}{\partial \psi} > 0$. Thus, *increasing punishment past a certain critical level can be counterproductive - leading to an increase in partial resistance*. Instead of giving the dominated group incentives to collaborate, increased punishment provides incentives to resist control.

The effect of the expected value of the random punishment allotted to Cooperators and Betrayers alike is affected by the relative values of Z and ψ.

$$\frac{\partial q}{\partial \phi}=\frac{-1(7-2\phi-Z-\psi)+2(3-\phi-\psi)}{(7-2\phi-Z-\psi)^2}=\frac{-1+Z-\psi}{(7-2\phi-Z-\psi)^2}.$$

In this equation, if the controlling group severely targets those who are Betrayed while Cooperating, $Z > \psi + 1$ then $\frac{\partial q}{\partial \phi} > 0$. *An increase in ϕ will produce an increase in partial resistance.*

Otherwise, if $Z < \psi + 1$ the derivative is negative; *an increase in ϕ will lead to a decrease in partial resistance*. Thus, depending upon the relative values for Z and ψ, it is also possible that an increase in the level of random punishment can spark an increase in the level of partial resistance.

It is interesting to note the importance of the variable Z in these results. In each equation, we note that if Z, or the penalty for Cooperation, is large enough, then an increase in the levels of the other penalties, ϕ or ψ, will result in an increased level of partial resistance. Thus, the addition of the variable ϕ as punishment for Betrayal is highlighted as having a negative effect upon the punishment strategies of the controlling group.

From these results it is clear that the issue of punishment and reward is significant for both the controlling and the controlled. If punishments and rewards are carefully applied then the controlling group can create a situation in which individual self preservation can severely constrain the level of resistance in a society. In other words, a type of collective action problem can be instituted to the benefit of the controlling group. However, lest these results be misinterpreted as "more punishment equals less resistance," it is important to note that if punishment is meted out carelessly then the opposite is likely to occur, "more punishment equals more resistance."

This model lends valuable insight into a previously puzzling question in Estonia's history. If we accept the argument that the Estonians faced a collective action problem, then we have an explanation for why the Estonians initially offered little or no resistance to the occupying Soviet force. Yet *after* occupation had taken place, a significant resistance movement emerged and thrived in Estonia. Given the constraints of collective action, it could be difficult to understand how such a movement could form. There was no weakening on the part of the Soviets' control: on the contrary, control increased. Appealing to the above model, we can reconcile the collective action argument with the emergence of very real and strong resistance of individuals and groups in Estonia.

Had the Soviets responded only to concrete actions taken against their occupation, there may have continued to be very little resistance, despite the Estonians' feelings. The collective action problem would have been in favor of the Soviets. However, Soviet leaders began to search for and deport *anyone* who they suspected of being their enemy.

> A special Soviet army unit that landed near Narva on February 14 [1944] had been instructed to eliminate all the civilians it encountered as potential enemies. Before their attack was stopped, this unit succeeded in murdering a large number of civilians, including a young woman and her infant. Although the Red army units sweeping into Estonia in the summer and fall of 1944 had no such instructions, they unleashed acts of unspeakable terror on the local population in many areas. Pillaging and looting were common, as well as the rape of captured women. In some parts of the country, they murdered entire families simply to crush any resistance before it had a chance to take root.[80]

This action is similar to that of punishing everyone, depicted in the model above. As the model demonstrates, the result is counterproductive for the occupying force. Through these actions, the Soviets unwittingly provided a motivating force for action!

> One by one, government leaders and other elite members were arrested, although they had not resisted Soviet aggression and had not worked against the occupation regime. People of any social

[80] Laar, 1992, p. 28.

> standing who made critical comments as they were accustomed to doing would vanish.[81]

> In one incident on September 21, 1944, the commander of a Soviet tank unit...ordered the murder of about twenty young Estonian men who had just surrendered without resistance. The troops lined up the bodies along the road and drove the tanks over them repeatedly, until there was little left of the young men.[82]

The haphazard manner in which the Soviets arrested and deported Estonians made many of the Estonian people feel that they had no strategy that would ensure safety. Resistors and collaborators alike were subject to death or deportation.

Through these actions, the impact of the collective action problem was decreased. Instead of facing a choice between resistance with probable death or collaboration, Estonians faced the prospect of being deported or killed whether they collaborated or not. Due to the random nature of the Soviet attacks, designed to scare the Estonians into submission, even collaborators could be punished. Hence, collaboration began to lose its appeal. In addition to the fulfilment of patriotic duty, resistance began to offer the option of safety. As the threat of arrest grew, many Estonians found that their only hope of self preservation was to seek refuge in the woods. Collaboration offered little benefit. The Soviets, in

[81] Taagepera, 1993, pp. 66-7.
[82] Laar, 1992, p. 28.

their attempt to eliminate any potential threats to the new regime, effectively decreased the incentives to obey.

By becoming more severe, the Soviets created a situation in which it was in the interests of the Estonian population to resist. As demonstrated in the model, the Soviets' mistake was in destroying the incentives to collaborate. Because the Estonians could be punished even if they collaborated with the Soviets, the strategy of collaboration ceased to be the single best strategy. Instead, many Estonians found that they could do at least as well, if not better, by resisting.

At this point, a comparison of the Russian experiences with Soviet tactics might be of interest. In the 1930s, the Bolshevik leaders also experienced brutal treatments from Stalin, during a period known as the Terror, under which a significant number of communist party leaders were arrested and killed or imprisoned. Unlike the Estonian example, however, these actions served only to stifle the emerging signs of opposition within the party.

The disparity between these cases seems to contradict the results of the model until we examine the Russian case more closely. In the Russian context, although punishments were indeed severe and appeared to be random, the situation did not approximate a Ruthless Punishment model because rewards for good behavior continued to be allocated. In fact, the

Soviet system of hierarchical privileges was constructed in such a way that the principle means of achieving a higher rank, and the greater perks associated with it, was through the displacement of one's superiors. The author Alex De Jonge refers to the purge as, "a power struggle, combined with a means of providing career opportunities for a hungry generation waiting in the wings."[83] Random as the punishments may have appeared, Stalin was merely applying a strong version of the Punishment/Reward model, because collaborators continued to be rewarded and had very strong incentives to Betray others, in hopes that they might gain from their demise.

Corrections

Returning to the issue of errors made through use of the Ruthless Punishment model: the same model allows us to understand how a controlling could rectify the resistance problem it had created. Through a more precise application of rewards and punishments, specified in the original Punishment/Reward model, the regime can re-create a collective action problem.

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[83] De Jonge, Alex, 1986.

The Soviet regime eventually used these tactics to regain control of the Estonian population. Importantly, over time sanctions became more understandable - punishments were still harsh, but were given in response to overstepping *known* bounds, in contrast to the earlier inexplicable deportations. With more certainty in their lives, people began to relax. The relaxation provided relative comfort but affected the will of the people in a crucial way: their incentive to fight was declining.[84] Recalling the model, the strategy of cooperation became, once again, the safer option. Because the probability of punishment was high, most people had incentives to collaborate with the Soviets because that was the better of two undesirable strategies.

> Still, as terror subsided, so did resistance. When the choice seemed to be between *surm siin või Siberis* ("same death either here or in Siberia") one might as well fight. But now it became a choice between death and collaboration, and few chose death.[85]

By adding certainty to punishments, the Soviets recreated the collective action problem. In consideration of one's own welfare, most people chose the safer option of collaboration. Given the circumstances, it is understandable that it took many years to revive and organize movements in opposition to Soviet occupation.

[84] Taagepera, 1993, p. 89.
[85] Taagepera, 1993, p. 89.

> The attitude of the population was one of submission to manifest force, combined with passive resistance and continual mental reservations about the more absurd aspects of Sovietization.[86]

The post-war specter of Stalin left no room for any political or economic dissent, and deportation to Siberia provided an incentive to cooperate. Resistance was, if at all, expressed only passively. Organization of groups was branded fascist or nationalist and was met with swift and brutal repression. The Soviets continued to force, or provide incentives for, ethnic Russians to colonize Estonia, thereby using ethnic cleavage to provide a counterbalance to the local population. This tactic, among other effects, created a type of civilian garrison that made it more difficult for Estonians to organize, thereby constraining the possibility of inter-Estonian cooperation through information flows (increased λ.)[87]

Organized Resistance

The above models demonstrate the ability of the controlling group to manipulate the payoffs and, hence, the strategies of the controlled. However, we can imagine that the tools of one group may also be used by

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[86] Taagepera, 1993, p. 77.
[87] Taagepera, 1993, p. 82.

another. There is no reason to assume that the stronger group will be unique in its use of tactics to induce preferable outcomes. An interesting question, then, addresses what circumstances would arise if both groups tried to use punishment strategies in order to "persuade" individuals to comply with competing goals.

Olson states that if a community suffers from a collective action problem, then selective incentives are necessary in order to dissuade members from neglecting to contribute. The Punishment/Reward game creates enormous individual incentives to betray others. If a weaker group wished to overcome these odds, it would have to change the payoffs again.

	Cooperate	Betray
Cooperate	4-ϕ, 4-ϕ	-Z, 4-D
Betray	4-D, -Z	-ψ,-ψ

Figure 12 -- Counter-Force Model

Again, this change may be effected by either rewards or punishments, or by a combination of both. For simplicity, only punishments will be shown here. If a group applied selective incentives in such a way that the punishments imposed for Betrayal were greater than those given by the other group for Cooperation,

$$4\text{-}D < 4\text{-}\phi,$$

then the new Nash equilibrium within the community would be Cooperation.

Comparative Statics

Comparative statics are helpful to determine the relative effects of the punishments levied by the opposing groups. Without comparative statics, the outcomes in this model are difficult to predict We would expect to observe that as the strength of one type of punishment increases, the effects of adversarial punishments should diminish. In other words, we would expect that as the level of punishment, D, of the weaker group increased, then an increase in the punishment level of the controlling group would be less effective or counterproductive in deterring resistance. Similarly, we would expect that as the punishment levied by the controlling group grows stronger than that of the weaker group, then an increase in the level of punishment by the weaker group would be less effective in prompting resistance. If this is, indeed, the case, then we would expect to observe an escalation in punishment levels from the opposing groups as each group tries to outdo the other in an attempt to wrest control of the situation.

With these expectations in mind we first compute the effect of the resistance punishment, D, upon the level of partial resistance.

$$\frac{\partial q}{\partial D} = \frac{-1(8-\phi-Z-D-\psi)+(4-D-\psi)}{(8-\phi-Z-D-\psi)^2} = \frac{-4+\phi+Z}{(8-\phi-Z-D-\psi)^2}$$

These results indicate that if the controlling group is punitive, $\phi + Z > 4$, then $\frac{\partial q}{\partial D} > 0$, or *an increase in the level of punishment for Betrayal, D, will lead to an increase in partial resistance if the levels of punishment for Cooperation while Betrayed, Z, and/or the expected value of the random punishment for Cooperation, ϕ are above a critical point, 4.*

If the group is less punitive, $\phi + Z < 4$, then $\frac{\partial q}{\partial D} < 0$. If the levels of punishment for Cooperation while Betrayed, Z, and/or the random punishment for Cooperation, ϕ, are below the critical point, 4, then *an increase in D will lead to a decrease in partial resistance*. Contrary to our expectations, levels of punishment allocated by the opposing force can have the effect of *increasing* resistance when coupled with an increase in the punishment for Betrayal.

The effect of mutual punishment for Betrayal (BB) will be shown next.

$$\frac{\partial q}{\partial \psi} = \frac{-8+\phi+Z+D+\psi+4-D-\psi}{(8-\phi-Z-D-\psi)^2} = \frac{-4+\phi+Z}{(8-\phi-Z-D-\psi)^2}$$

The results are the same as in the previous case. If the controlling group is punitive such that $\phi + Z$ are above the critical point 4, then *an increase in* ψ, *the mutual punishment for mutual Betrayal will lead to an increase in partial resistance.*

If $\phi + Z$ are below the critical point, then *an increase in* ψ *will lead to a decrease in resistance*. Again, contrary to expectations, we do not find that the level of punishment, D, levied by the opposing force has any effect upon the impact of the variable ψ.

Also, surprisingly, we note that an increase in punishment can lead to an increase in partial resistance. This result has the effect that the controlling group could undermine its own efforts. Perhaps, however, this result should be expected. In punishing Betrayers, the resistance group essentially recreates the Ruthless Punishment model, thus inciting rebellion as a reaction to most types of punishment.

The impact of Z, punishment for Cooperation when Betrayed, (CB) will be assessed next.

$$\frac{\partial q}{\partial Z} = \frac{-1(4 - D - \psi)}{(8 - \phi - Z - D - \psi)^2}$$

In this case, the level of D can have an impact upon the effect of punishment, Z. If we encounter a situation of strong counter-force such that $D + \psi > 4$, then *an increase in Z will lead to an increase in partial resistance*. Thus, if the resistance group is able to set the level of D very high, then it can cause the controlling group to undermine its own efforts when raising penalties.

However, if the resistance group cannot ensure a high D and if the controlling group sets a low level for mutual punishment, ψ, then $D + \psi$ may fall below the critical level and *an increase in the punishment, Z, will have the effect of decreasing partial resistance.*

The equation for the effect of random punishment, ϕ, has similar results.

$$\frac{\partial q}{\partial \phi} = \frac{-1(4 - D - \psi)}{(8 - \phi - Z - D - \psi)^2}$$

Again, the variable D can have an impact upon the outcome. If the weaker group can effect a situation of counter-force, D + ψ > 4, then *an increase in ϕ will lead to an increase in partial resistance*; so if the resistance group is able to set a high penalty, D, then it can promote increased resistance. If it cannot set the level sufficiently high, in such a way that D + ψ < 4, then *an increase in ϕ will have the effect of decreasing resistance.*

Essentially, by adding their own use of punishment and/or reward, the weaker group can establish circumstances in its favor in two ways. First, it recreates the Ruthless Punishment model - giving incentives for its own members to increase their levels of resistance. Secondly, because it creates this particular situation itself, the weaker group may have another element of control over the game. We note from the last two results that if the weaker group is able to set a level of punishment, D, high enough (D > 4-ψ) then the previous strategies of the controlling group - raising penalties to decrease resistance - will be undermined.

The importance of this last result should be highlighted. The weaker group gains both from the Ruthless Punishment model and from the Counter-Force model because both provide motivations for resistance among members of the weaker group. However, the weaker group stands to gain more from instituting the Counter-Force model, because this situation allows them an element of control; through manipulation of the levels of their own penalty, D, the group can cause the controlling group to undermine their own efforts. Additionally, because the weaker group, and not the controlling group, controls the level of D, it can be much more difficult for the controlling group to correct the problem and return to the more favorable circumstances of the Punishment/Reward model.

The results are contrary to the initial expectations that each group would strive to outperform one another by successively raising penalty levels. In contrast, any increase in the levels of punishment levied by the controlling group will be counterproductive, provided the weaker group sets its penalty sufficiently high. Thus, through counter-strategies, the weaker group may be able to gain some control over its own members and, to a limited extent, over the controlling group.

It is important to note that the above results are contingent upon the ability of the weaker group to maintain a sufficient level of counter-force punishment $D > 4-\psi$. If, for any reason - e.g. lack of resources, information, manpower, etc...- this group is unable sustain this level of punishment, then the situation will be reversed. In this case, the results will no longer be in the weaker group's favor. Once the level of D falls below this critical level, then it will once again be the case that an increase in punishment levied by the controlling group will lead to decreased resistance in the weaker group. The collective action problem will be restored.

The model bears resemblance to the case of the resistance movement in Estonia. In the woods, groups of Estonians organized and fought against Soviet occupation of their country using military force, guerrilla tactics, and any other means available to them. The most famous pro-independence guerrilla groups, ranging in size from 1 person to groups of several hundred, were the *metsavennad*, the Forest Brothers.[88] These resistors had mixed goals. They organized both to protect themselves and to try to overthrow the occupying forces. Initially, the belief was strong that when the war was over the West would follow the promises made in the Atlantic Charter, which guaranteed a free Europe, and would assist them by fighting the Soviets.[89] With this belief. many chose to hide, to collect weapons, and to formulate plans in order to be of assistance to their liberators. When this assistance did not materialize, groups were divided between those who openly fought the Soviets and those who took to the woods only to save themselves.

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[88] Taagepera, 1993, p. 79.
[89] Laar, 1992, p. 75.

These groups were organized both by the intense need of one another for survival, and through tactics that Olson claims are necessary. The groups provided selective incentives for Cooperation.[90] These tactics resembled those in the model. Through punishments, torture, deportation, and death, the Soviets had created a system in which individuals had a self interest in protecting themselves by Betraying others. The partisans responded by instituting punishment for collaboration, D. In so doing, they succeeded in changing the payoffs in such a way that many Estonians had incentives to Cooperate with and help the Forest Brothers.

Partisans in the Baltic states and in Ukraine killed many Soviet collaborators, creating disincentives to Betray the resistance movements or to help the occupying powers in their fight against the resistance.[91]

> Deliberate acts of political terror included the killing of specific individuals after a verdict had been reached. Targeted individuals were usually accused of collaboration with the occupation authorities. The partisans selected only those who demonstrated a desire for active cooperation with the authorities, and not those who simply fulfilled obligatory duties.[92]
>
> Usually, the individuals representing a danger to the local population first received a letter of warning; the death penalty was carried out when the warnings proved ineffective.

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[90] This is Olson's term and refers to a group's strategy of punishing defectors and rewarding cooperators in order to encourage cooperation. 1982.
[91] Laar, 1992, p. 27.
[92] Laar, 1992, p. 92.

> Those who burdened the population with excessive duties, participated in arrests and raids, harassed or abused the local people, appropriated arrested persons' property, or went to live in buildings confiscated from their owners received these warnings from the partisans. Collaborators with the Soviet security apparatus were the most frequent recipients of more tangible warnings.[93]

The partisans used brutal force and yet their tactics were strategic. The goal was to provide protection to the population and to encourage resistance; were they to mistakenly harm Cooperating Estonians, their goals would not be obtained.

> Many recollections emphasize that the people killed by the Forest Brothers clearly deserved their fate. Indeed, random and senseless murders would have harmed the partisans' relations with the local population. The Forest Brothers would have perished quickly without popular support.[94]

The incentives for the Brothers to Cooperate with one another were furthered by the fact that, having chosen to take to the woods, the high risk of Soviet punishment if discovered made it very difficult to return to society. In terms of the model, this situation is one in which the payoffs to Betrayal are lower than those for Cooperation. Despite some Soviet attempts to lure the Brothers out of the woods with promises of safety; if a Forest Brother was discovered in public, he or she

[93] Laar, 1992, p. 93.
[94] Laar, 1992, p. 94.

would be arrested.[95] Information about these arrests spread quickly, and those who might have accepted the "amnesty" realized that the better option was to remain in the woods.[96] Some Brothers were able to obtain false documents, reenter society, and lead normal lives; however, many others had to stay hidden in order to save their lives and those of their friends and loved ones. Given these circumstances, the resistance movement lasted many years.

The model indicates that the payoffs would be determined by the resources available to each group. So long as the Estonians held sufficient resources, they could continue to impose the Counter-Force model. Eventually, however, their resources and manpower declined. The superior numbers, armament, and mobility of the Soviets was successful in breaking into and destroying the groups.[97] Many Forest Brothers unfortunate enough to be caught alive were tortured until they revealed the names and locations of their members. In this way, the punishment for Cooperation was increased. Other Estonians were offered incentives, threatened, or tortured to induce them to Betray the Forest Brothers and other groups, either in terms of revealing their identities and/or locations or

[95] Laar, 1992, p. 58.
[96] Here, it is important to note the sequential nature of the game. The Soviets essentially used a grim trigger strategy in response to resistance activity among the Estonians. If an Estonian had been a Forest Brother, then he was arrested. A different strategy, on the part of the Soviets, would have produced different behavior from the Estonians.
[97] Taagepera, 1993, p. 80.

in terms of inducing Estonians to infiltrate groups of Forest Brothers and to actively serve as spies - eventually leading to the capture of the groups.

Information about which game is being played is understandably crucial in choosing strategies. Knowledge about the members of a given group additionally plays a large role. If a group must rely on selective incentives for survival, then all members must be prepared to apply them. If some members work actively against the group, then the incentives fail. This proved to be the case for the Partisans. As the number of infiltrations grew, the resistors were unwilling to trust one another, and Cooperation among groups diminished, breaking the ability of the groups to fight their enemy. Finally, with decreased Cooperation among the resistors, the Soviets were able to arrest or kill off most of those who posed a threat.[98] With the demise of the resistance, the Soviets broke the will of the population to support armed struggle. Through arrests, deportations, murders, or escapes to the West, Estonians who might have fought gradually diminished.

Successful Resistance

[98] See Laar, 1992.

We have observed how a decrease in the ability of the weaker group to maintain a sufficient level of punishment, D, can reduce that group's influence upon the game. This decrease in influence returns the situation and the control to the controlling group. Arguably, a similar failure, due to lack of resources or due to some other factor, on the part of the controlling group to maintain punishment at levels sufficient to deter resistance would result in that group's loss of control. Indeed, the comparative statics results for the Punishment/Reward model reveal that a decrease in the level of punishment, Z, (for being Betrayed while Cooperating) results in an increase in partial resistance. Similarly, depending on the relative values for Z and ψ, a decrease in punishment, ϕ, for mutual Cooperation will also increase partial resistance. Although more careful analysis would be necessary to determine the factors which allow a weaker group to overthrow a controlling group, this examination provides a rough approximation of how this process could commence.

The above argument corresponds with Olson's insight regarding the breakdown of the Soviet regime. Olson claims that a lack of resources, resulting from the defective Communist economic system, hampered the Soviets' ability to levy punishments, or, indeed, to compel the enforcers to levy punishments. This breakdown in the system of command led to a deterioration of the respect for and obedience to the

Soviet government.[99] Olson's insight is consistent with the results of this model. If a loss of resources significantly decreases the ability of a controlling group to punish and reward, then we would expect to observe a surge in resistance activity in the weaker group, and a breakdown in the power of the controlling group.

Games and Characteristics

The results presented to this point were derived from the premise that the original situation would be one in which members of the weaker group had original preferences corresponding to Harmony, or total Cooperation with one another. This assumption was made to demonstrate the potential difficulties faced by a controlling group when confronted with a united opposing group. Presenting these obstacles, suggestions were made within the model as to what tactics the controlling group could adopt to facilitate control. While enlightening, these preferences cannot be expected to occur in all circumstances. It makes sense that if the original situation were different, then we could expect different tactics on the part of the controlling group and different outcomes.

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[99] Olson, 1995.

This intuition is simple to demonstrate. Imagine, for instance, that the original situation within the weaker group is represented by a collective action problem.

	Cooperate	Betray
Cooperate	3,3	1,4
Betray	4,1	2,2

Figure 13 -- Collective Action Problem

In this case, the controlling group's task of discouraging Cooperation among members of the weaker group is facilitated. Recall from the first section that if the controlling group can restrict information among members, then Cooperation will be severely hampered. If, furthermore, the controlling group can slightly alter payoffs in such a way that rewards from cheating and the penalties from being cheated are increased, then the controlling group can succeed in obstructing possibilities for Cooperation in the weaker group.[100]

[100] These statements are based on results from Part 1.

Similarly, if the original preferences are such that members of the weaker group were largely antagonistic towards one another, then the controlling group would have little problem imposing control.

	Cooperate	Betray
Cooperate	2,2	1,4
Betray	4,1	3,3

Figure 14 -- Antagonism

In this case, due to prejudice, hatred, or some other reason, members of the weaker group are worse off if they Cooperate with one another than if they mutually Betray one another. The dominant strategy for these players is Betray, and the Nash equilibrium, Betray/Betray, is Pareto optimal. In this type of situation, no incentives on the part of the controlling group would be necessary to persuade members of the weaker group to collaborate.

From these simple examples, it is clear that the original circumstances are critical in determining the tactics used by each group as well as the outcomes. We can imagine that the original situation could be shaped by characteristics of the weaker group. For instance, it is easy to envision that if a group is united by a common bond such as a shared ethnicity, religion, language, culture, or other trait, that that group might be cohesive. In this scenario, the group's preferences might be more likely to resemble those of the harmony model. This type of group, as we have seen, would pose more problems for a controlling group and is more likely to successfully resist control.

This last statement lends weight to intuition suggested by Olson. Olson hypothesized that a common ethnicity and/or language would facilitate efforts of a weaker group to resist a controlling group.

> When the center is a system of extraction, it is only natural to want to escape it. To the extent that a group had a distinctive ethnic loyalty or language, it was better able to conspire and collude against the huge implicit taxes imposed by the center. Ethnic grievances and mutual trust within the group facilitate cooperation, and a separate language reduces the chances that the center will learn of a collusive discussion.[101]

This analysis demonstrates that if, indeed, a factor such as common ethnicity or language can unite a group, then Olson's intuition is correct.

If, in contrast, due to circumstances that could include linguistic or ethnic differences, distance between group members, or lack of information, a weaker group is fragmented in such a way that its members face a collective action problem, then the task of the controlling group is made easier. If, further, due to divisions that could stem from religion,

[101] Olson, 1995, p. 28.

class, ethnicity, culture, or some other factor, there exists large scale antagonism within a weaker group, then the controlling group's job is easier still. In both cases, the risk of resistance on the part of members of the weaker group is reduced significantly.

This last result should not be interpreted as meaning that a controlling group would have free reign over the latter two groups. Appealing to intuition found in the Ruthless Punishment model, it is simple to show that abuse of power could spark cohesion and resistance even in members of the antagonistic group. If penalties and hardship are imposed on the weaker group to such an extent that the payoffs are altered, then it may become in the players' interest to resist.

	Cooperate	Betray
Cooperate	$2-\chi, 2-\chi$	$1, 4-\varepsilon$
Betray	$4-\varepsilon, 1$	$3-\gamma, 3-\gamma$

Figure 15 -- Antagonism with Ruthless Punishment

If the controlling group allows the power exerted over the weaker group to escalate to the extent that,

$$2-\chi>4-\varepsilon,$$

so that individuals gain more from mutual Cooperation than from Betraying a Cooperator, then the Ruthless Punishment model will be recreated. As we have learned in this model, resistance will increase with increases in punishments, and members of the weaker group will have an incentive to overcome their differences and Cooperate with one another against the controlling group. Through this result, we see that even in the best case scenario for the controlling group, treatments of the weaker group should be handled with caution.

Conclusion

The models presented here are very simple representations of the potential circumstances facing opposing groups. The power of these models lies in the fact that they suggest how tactics taken by opposing groups in a power struggle can alter the game in favor of one group or another. In cases of control or resistance, decisions and actions can tend to be reactionary or based on emotion. These models serve to indicate why some tactics may be beneficial for the goals of one group, whereas others may be counterproductive.

These models additionally highlight the importance of the collective action problem in analysis of power struggles. As Olson suggested, the collective action problem does play a role in undermining the amount of resistance offered to the advances of a controlling group. I demonstrate that if this type of hindrance to action does not already exist among members of the weaker group, the controlling group can use a system of rewards and punishments to create a collective action problem. Once this situation has been attained, however, the controlling group must avoid being over-zealous in its punishments, or it could actually produce incentives to resist.

Finally, these models demonstrate the profound effect of original circumstances upon strategies and outcomes in the game. If the weaker group originally holds preferences corresponding to Harmony, or total cooperation, then the controlling group must strive to suppress resistance and must concern itself with the possibility of counter-force activity from the weaker group. If, in contrast, the weaker group originally holds preferences corresponding to a collective action problem or to antagonism, then the task of the controlling group is facilitated, and the weaker group will tend to be less likely to attempt resistance activity.

Power struggles have existed throughout history. Prescriptions for control have ranged from Machiavellian to pacifist. Rather than suggest an optimal strategy for either type of group, the intent of this work is to highlight potential actions that may be made in the power struggle and to demonstrate the effects that can result from these actions. Through this analysis, we may obtain greater understanding of the issues related to the quest for power.

Appendix A

The goal, here, is to find a value for λ, the probability level of reliable information, such that a person will be indifferent between always cheating and playing honest. To determine this value, we must compute that point at which the payoffs are equal. A player knows that with probability λ, her opponent will know what she has done in the past, and with probability $1-\lambda$, the opponent will not have this knowledge.

The value for cheating would yield α in the first round of the Prisoners' Dilemma and a discounted sum of payoffs afterward, the payoffs would depend on whether the new opponent detected the previous cheat, or not as well as on whether or not the opponent cheats:

<u>Cheat</u>:

If opponent plays Honest :

$$\lambda\{\alpha + \delta[(1-\lambda)\alpha - \lambda\beta]\ \} = \lambda\{\alpha + \delta[\alpha - \lambda(\alpha + \beta)]\ \}$$

If opponent cheats:

$$(1-\lambda)\{0+\delta[(1-\lambda)\alpha-\lambda\beta]\ \}=(1-\lambda)\{\delta[\alpha-\lambda(\alpha+\beta)]\ \}$$

The value for playing Honest would yield 1 in the first round, if the opponent also plays Honest, and a discounted sum of payoffs in the next rounds. These payoffs depend upon the probability, λ, that the opponent correctly detects that the player plays Honest and on the opponent's strategy of playing Honest or Cheat.

Honest:

If opponent plays Honest:

$$\lambda\{1+\delta[\lambda-(1-\lambda\beta)]\}=\lambda\{1+\delta[\lambda(1+\beta)-\beta]\}$$

If opponent cheats:

$$(1-\lambda)\{-\beta+\delta[\lambda-(1-\lambda)\beta]\}=(1-\lambda)\{-\beta[1+\delta(1-\lambda)]+\delta\lambda\}.$$

Recall that we wish to find the value of λ such that a player is indifferent between playing cheat or honest. Mathematically, we wish to find λ such that,

$$\lambda\left\{\alpha+\delta\left[\alpha-\lambda(\alpha+\beta)\right]\ \right\}+\ \left\{(1-\lambda)\left\{\delta\left[\alpha-\lambda(\alpha+\beta)\right]\ \right\}=\right.$$

$$\lambda\left\{1+\delta\left[\lambda(1+\beta)-\beta\right]\right\}+\ (1-\lambda)\left\{-\beta\left[1+\delta(1-\lambda)\right]+\delta\lambda\right\}.$$

The equation can be rewritten as:

$$\lambda\alpha+\lambda\delta\left[\alpha-\lambda(\alpha+\beta)\right]+\delta\left[\alpha-\lambda(\alpha+\beta)\right]-\lambda\delta\left[\alpha-\lambda(\alpha+\beta)\right]=$$
$$\lambda+\lambda\delta\left[\lambda(1+\beta)-\beta\right]-\beta\left[1+\delta(1-\lambda)\right]+\delta\lambda+\lambda\beta\left[1+\delta(1-\lambda)\right]-\delta\lambda^{2}$$

Solving for λ, we obtain:

$$\lambda=\frac{\delta\alpha+\beta+\delta\beta}{1+\delta+\beta+2\delta\beta+\delta\alpha-\alpha}.$$

This value for λ indicates the level of the probability of information necessary to sustain cooperation in a group which plays Adjusted Tit For Tat with one another.

Appendix B

To determine the sign for the partial derivative of F(λ) with respect to λ, recall that

$$\delta \geq F(\lambda) = \frac{\lambda(\alpha - \beta - 1) + \beta}{\lambda(1 + 2\beta + \alpha) - (\alpha + \beta)}.$$

$$\frac{\partial F}{\partial \lambda} = -\frac{\alpha^2 + \alpha(\beta - 1) + \beta^2}{\left(\lambda(1 + 2\beta + \alpha) - (\alpha + \beta)\right)^2}.$$

Because the denominator is positive, and because there is a negative sign in front of the equation, we know that the sign of the partial derivative must be the opposite of the sign of

$$\alpha^2 + \alpha(\beta - 1) + \beta^2.$$

First observe that when $\beta \geq 1$, all terms are positive, so the numerator is positive. Additionally, notice that the numerator must pass through zero before it can have any negative values. This means we wish to find where this equation is equal to zero. Using the quadratic equation, where we treat α as the variable, this is where:

$$\alpha = \frac{-(\beta-1) \pm \sqrt{(\beta-1)^2 - 4\beta^2}}{2} = \frac{1-\beta \pm \sqrt{1-2\beta-3\beta^2}}{2}.$$

The term inside the square root is negative when $\beta=1$. So, we need to determine whether there are any $\beta>0$ values that yield a $\alpha>1$ value. To determine this we look at the larger (positive) term for the square root to find the values of α such that

$$1 < (\alpha) = \frac{1-\beta+\sqrt{1-2\beta-3\beta^2}}{2}.$$

Multiplying both sides by 2 and bringing the $1-\beta$ term to the left hand side, we have

$$1-\beta < \sqrt{1-2\beta-3\beta^2}.$$

Squaring both sides, we obtain

$$1+2\beta+\beta^2 < 1-2\beta-3\beta^2$$

or

$$4\beta+4\beta^2 = 4\beta(1+\beta) < 0.$$

Because this last inequality is never satisfied for $\beta>0$, we have there is no $\beta>0$ that will give a zero for the numerator for any $\alpha>1$. Thus, for $\alpha>1$, and $\beta>0$, it is always true that the partial derivative with respect to λ is negative.

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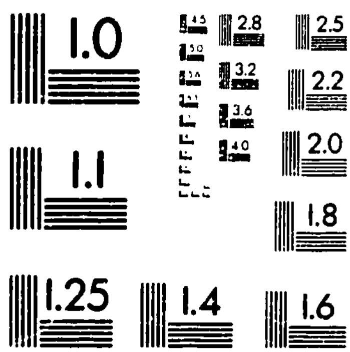
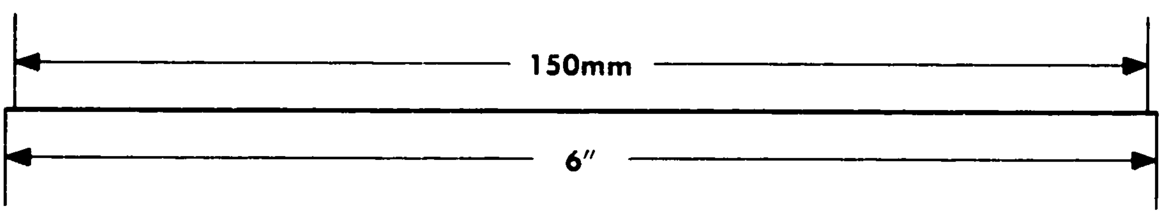
IMAGE EVALUATION TEST TARGET (QA-3)





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